On-farm Level

- The land of cropping type C, which is cultivated with rice in Kharif, will be provided with an open deep drain between link water courses and along internal water courses. The designed discharge is 1.34 cusecs per 1,000 acres.

- The land of cropping types A and B will be provided with a shallow drain along internal water courses.

- Open deep drains will be constructed along the main water courses in the entire Project Area. Their designed discharge is 0.17 cusecs per 1,000 acres.

Main and Sub-Main Drains

- The sub-main drains will be laid between the distributaries. Their designed discharge is 0.17 cusecs per 1,000 acres.

- The main canals in the eastern part of the existing Haidrin pumping station will be widened, and the other main canals and new pumping station will be newly provided .

IV.2.6. Farm Land Development Plan (On-farm Level)

The provision of on-farm facilities such as water courses, farm drains, and farm roads is essential works for irrigated agriculture with farm mechanization, and farmers' eagerness for agriculture will act as the prime mover. With their support, the rationalized land parcelling and land allocation will be materialized, which are prerequisite for modernized agriculture. Thus, the modernized irrigation and drainage systems as well as the new organization for farm management will be established at an early stage.

a) Premises in Farm Land Development

Farm Management

A cultivation area per farm household in the Project Area is 16 acres (6.48 ha) on an average. For common use of farm roads and irrigation and drainage canals, especially for rotational irrigation based on a rationalized irrigation schedule, Water Users Groups(WUG) will be organized by farmers in a cultivation area of about 80 ac (32.38 ha) forming one rotational area.

Crops

The cropping intensity in Kharif will increase to 60 per cent, that is 20 per cent for raising rice of high yield varieties and 40 per cent for upland crops, and the remainder of 40 per cent will be fallowed. All rabi crops will be upland crops.

Farm Practices

For farm practices, the minimum-level mechanization system will be established mainly with tractors for deep plowing and threshers for threshing works.

However, these machines aim to supplement the manpower and livestock power, major powers of farm works, in the busiest farming period.

b) Land Parcelling

(1) Principle for Land Parcelling

To materialize the farm land parcelling satisfying all the above-mentioned requirements in the Project Area where there are existing water courses, due attentions should be paid to the following points;

i) to plan the land parcelling in close relation with the farm management plan;

ii) to plan it for rationalized irrigation and drainage water control; and,

iii) to plan it for rationalized farm management for rice and upland crops cultivation.

Further details are as follows:

i) to determine the location of major service roads and access roads as the base of land parcelling which is made based on the proposed Water Users' Association, unit farm management group serving the area of about 80 ac (32.38 ha), as well as the rural community development and public facility construction plans.

ii) to determine the location of irrigation and drainage canals in consideration of topographic conditions, separation of irrigation and drainage canals, lengths of terminal canals, and rotational irrigation. To systematize and simplify the water supplying system at on-farm level, each rotational area should have one Nakka.

iii) to plan uniform plots in size as many as possible to simplify the extension of new techniques in cultivation to farmers. If all the farm plots are almost in the same size, a certain fixed quantity of agricultural chemicals can be sprayed to each farm plot to control diseases and insects. The same thing can be said in fertilizer application. Furthermore, planning and execution of both puddling works by tractors and irrigation water management for puddling will become simple and easy.

(2) Design of Rotational Areas

In the farm land development mentioned above, the following standard sizes of unit areas are proposed:

One irrigation unit	1 acre	(0.41 ha)
One irrigation block	16 acres	(6.48 has)
One rotation area	80 acres	(32.38 has)
One chak	350 acres	(141.65 has)

i) irrigation unit: unit farming lot on an average

ii) irrigation block: irrigation block which is covered by the link water course

iii) rotation area: area covered by the internal water course and those who cultivate the rotation area will belong to the water users group. Offtake to this area is named "Nakka".

iv) chak: area covered by the main water course whose head is named the "outlet".

The standard design of chaks, the rotation areas and so on are shown in Drawing No.016.

c) Terminal Water Management System

From an outlet to be constructed on the minor canal, the main water course will stretch out, and from a nakka to be constructed on the main water course, the internal water course will stretch out. The length of an internal water course will be about 2,000 feet (610 m), and the internal water course will command an area of about 80 acres (one rotation area). To deliver irrigation water from the

internal water course to farm lots, a link water course will be provided for an area of about 16 acres, one irrigation block.

The delivery of irrigation water form an internal water course to link water courses is planned to be simultaneously made, while the distribution of water from a link water course to farm lots is planned to be made in rotational way. Hence, the required cross-section of an intenal water course becomes small towards its downstream, and its terminal section corresponds with that of the link water course in size. Irrigation water supply during land soaking and land preparation for rice cropping will be carried out within 40 days. In this case, the design discharge of a terminal canal, internal water course, is 0.0113 cusec/acre (0.79 lit/sec/ha) assuming 60 per cent of cropping intensity and premising that a discharge of the link water course is 0.0177 cusec/acre (1.24 lit/sec/ha).

The terminal irrigation facilities are enumerated below:

Outlet: Facilities to divert irrigation water from a minor canal to main water courses. The facilities will be provided with a rectangle gate to control and with a circular gate to regulate the flow of water to main water course. This gate will be constructed, operated and maintained by the Irrigation Department.

Main Water Course:

Unlined irrigation canals to convey water from an outlet to internal water courses. Its designed discharge has been determined from the peak demand water allowance of 9.23 cusecs per 1,000 acres, which is corresponding to 0.645 lit/sec/ha; however, the design discharge of a main water course should not be less than most of the main water courses that are located at the downstream.

Nakka: Facilities to divert irrigation water from a main water course to internal water courses.

Internal Water Course:
Unlined irrigation canal to convey water from a nakka to link water courses. The designed discharge of the canal is 0.0113 cusec/ac (0.79 lit/sec/ha).

Division Box: Device to check water level of an internal water course and to divert water to a link water course.

Link Water Course:
Irrigation canal to convey water to farm lots. The designed discharge is 0.0177 cusec/ac (1.24 lit/s/ha)

Drainage System

The farm drains are the unlined terminal drainage canals to be constructed in each irrigation rotation area, and are classified into two as follows;

- Shallow farm drain: to be provided along an internal water course in farm lands for cropping Types A & B,

- Deep farm drain: to be provided in farm lands for cropping Type C between link water courses.
  The designed discharge is 0.17 cusecs per 1,000 acres.

IV.2.7. Drinking Water Plan

This section discusses necessary conditions in water supply for animal/poultry husbandry and for miscellaneous use.

a) Drinking Water Requirements

In estimating the drinking water requirements, the forecasted population in the year 2000, the proposed breeding numbers of animals and poultry, and water requirements per head per day were studied. The population in 2000 was estimated in Section IV.3.6. and the proposed breeding head of animals are discussed in Section IV.3.5. The water requirements per head per day are assumed as tabulated below in consideration of the local conditions and livestock breeding practices, and the total daily water requirement is also calculated below.

Daily Drinking Water Requirement

Descriptions	Population	Unit Requirements (cu.f/head/day)	Total Daily Requirements (cu.f/day)
Inhabitants	420,000	3.5	1,470,000
Cattle	163,000	1.8	293,400
Buffaloes	39,600	1.8	71,280
Asses	66,500	1.8	119,700
Sheep	197,600	0.7	138,320
Goats	120,700	0.7	84,490
Chicken	452,000	0.2	90,400
Miscellaneous use			232,410
Total			2,500,000

The total daily water requirement is computed at 2.5 million cubic feet, which is equivalent to 43.40 cusecs.

b) Water Supply Method

Animal/poultry husbandry will be carried out in the villages where the owners of animals live. Since the villages are scattered in the whole Project Area, it will be necessary to convey drinking water to these villages through water courses so that farmers will divert drinking water from the water courses from the inlets installed by themselves.

Accordingly, the peak demand water allowance of 9.23 cusecs per 1,000 acres includes water for irrigation and drinking. The water allowance only for drinking use is calculated at 0.08 cusec per 1,000 acres inclusive of the conveyance losses in water courses.

On the assumption of water supply throughout the year, the annual drinking water requirement at Guddu Barrage Head Regulator is calculated at 0.053 million acre feet in Cases-1 and -3 and 0.048 million acre feet in Cases-2 and -4.

IV.3. Proposed Agricultural Development

IV.3.1. Proposed Land Use

The extension and widening of the Pat Feeder Canal would enable to irrigate some 612,000 acres of cultivation lands out of 615,200 acres of the arable lands. The arable lands include about 509,600 acres of the presently cultivated lands and about 105,600 acres of the present cultivable waste.

Based on the data available at present, the proposed land use for future would be as follows;

- Total Project Area : 688,000 acres (100%)
- Total Cultivation Area : 612,000 acres (89%)
- Total Uncultivation Area : 76,000 acres (11%)

No detailed land use maps nor soil and land classification maps, which are necessary for the determining a future land use. Specially for on-farm facilities development and land leveling, these basic maps are inevitably required.

IV.3.2. Proposed Cropping Pattern

1) Selection of Crops

The following major crops were selected for the future agricultural production in the Project Area;

Summer season cropping

Sorghum, rice, oil seeds such as sunflower and sesamun, etc.; pulses such as soybean, mung-bean (vigna radiata), mash (vinga mung); sugarcane and others (vegetables and fruits like lemon, mango, guava, etc.)

Winter season cropping

Wheat; oilseeds such as rapes and mustard, etc.; pulses such as gram (cicer arietinum) and lentil (Lens esculanta), etc.; fodders and so forth (berseems, etc.)

In selecting these crops, various factors were taken into consideration such as the results of farmer's intention survey conducted by the Study Team, governmental policies, forecasted demand and supply of food at both the provincial and national levels in the year 2000, natural conditions specially soil conditions inclusive of the present and expected soil salinity and texture and the limited water resources.

The farmers' intention survey for the selection of crops to be raised after the completion of the Project has revealed that the farmers have given the first to third priorities to rice, wheat, sugarcane, sesamun, mustard, barley and berseem. Some of the farmers select fruits and vegetable (See Appendix).

On the other hand, the forecasted demand and supply of food at the provincial level suggests that all kinds of food exclusive of fruits, mutton, fat and fish will be short in future, unless any measures are taken for the increasing production of food. At the national level, the forecasted demand and supply of food shows that the improvement in agricultural production will be particularly necessary for cereals (wheat, rice, feed grains like maize, sorghum and barley), pulses, oil seeds, vegetables and fruits.

As regards the selection of crops, the following should be noted;

(i) Inspite of the limited irrigation water available, rice has been selected as one of the major crops since irrigation for rice cultivation is one of the best countermeasures against soil salinization in its long-term performance. The farmers themselves also select rice as an important crop since it is one of the most profitable crops and the soils in the Project Area are suitable for its cultivation.

(ii) Wheat, oil seeds and pulses are the major crops presently grown in the Project Area both in summer and winter. These crops would be grown also after the completion of the Project.

(iii) Sugarcane has been selected taking into account the strong desire of farmers to raise this crop.

(iv) Sorghum and Rabi fodders have been selected for the proposed livestock farming described in Section IV.5.

(v) As regards sunflower and soybean, experimental cultivation of them has just started in the Project Area. The farmers have no experience in raising these crops. However, both the crops have been selected in consideration of the governmental policy.

2) Proposed Cropping Plan

Four cropping patterns have been formulated to cope with the different irrigation water allowances as discussed in Paragraph IV.2.3. "Irrigation Plan". In formulating the proposed cropping patterns, a cropping pattern was formulated for Case 3, and then this pattern was modified for the other cases by using the irrigation water allowance in each case as a conversion factor. The cropping pattern in Case 3 consists of Cropping Types A, B and C which correspond to the following three profile salinity classes, respectively.

Cropping Type	Profile Salinity Class (Soil depth: 1.8 m)
A	Non-saline and non-sodic throughout the profile
B	Slightly saline (4 to 8 mmho/cm)
C	Saline (8 to 15 mmho/cm)

Out of these cropping types, rice cultivation is scheduled in both Cropping Types B and C. It is expected that salt substance will be leached by irrigation water during rice cultivation and that irrigation water will prevent salt from coming up to top soils from subsoils. It is noted that rice cultivation for leaching purpose is also recommended by Dr. M. Bashir Choudhri, Director General of the Soil Survey of Pakistan, Lahore.(see his work "Rice Culivation in Pat Feeder Area", herein quoted, pages 76 to 79 of Appendix III.2-4.)

Areas of which soils are more saline than 15 mmho/cm will be planted to no crops. The cropping calendar and crop rotation plan are illustrated in Figures IV. 3-1 and 3-2.

In Cropping Type A a variety of crops can be selected due to few limitations. In Type B rice will be grown in 25 per cent of the relevant area every year so that the entire farm lands in the area

will be leached within a four-year period by irrigation water for rice. After harvesting rice, upland crops will be raised in the subsequent three years. The ordinary cropping of upland crops, specially these with a high water efficient, could be introduced after rice cultivation. In Type C rice is grown every year in six per cent of the project area. After harvesting rice, pulses and fodder crops could be raised.

A cropping area of each crop in the proposed cropping pattern has been determined taking into account the study results on demand and supply of food in 2000 as well as farmers' intention on farm management after the Project. Cropping Types B and C in which rice is one of the selected crops will be mainly concentrated in the downstream area of each distributary where "Slightly Saline Soils" and "Saline Soils" in Figure III.2-4 are predominant.

It is expected that the cropping area of each crop will be determined based on a criteria to be worked out through further comprehensive studies specially in the aspect of soil salinity control.

Ill-effects on the growth of dry crops caused by rice cultivation is mostly ascribed to the lack of drainage systems and organization for systematic on-farm water management. This problem could be overcome by systematic water management after the construction of the proposed drainage systems (see 4.2.5. "Drainage Plan" and 4.2.6. "Farm Land Development)

In relation with the proposed cropping pattern, it is noted that applied research data of the Project Area such as those on optimum planting and harvesting time under modernized irrigation and proper crop rotation in connection with soil salinity control, etc. are not available at present.

Table IV.3-1 Proposed Cropping Plan[1/]

Crops	Case 1 Intensity	Case 1 Area	Case 2 Intensity	Case 2 Area	Case 3 Intensity	Case 3 Area	Case 4 Intensity	Case 4 Area
1. Kharif								
a. Sorghum	(9.0)	55,100	(7.0)	42,800	(9.0)	55,100	(7.0)	42,800
b. Rice	(20.0)	122,400	(17.0)	104,100	(20.0)	122,400	(17.0)	104,100
c. Oilseeds	(14.0)	85,700	(12.0)	73,400	(14.0)	85,700	(12.0)	73,400
d. Pulses	(12.0)	73,400	(10.0)	61,200	(12.0)	73,400	(10.0)	61,200
e. Sugarcane, Misc.[2/]	(5.0)	30,600	(4.0)	24,500	(5.0)	30,600	(4.0)	24,500
Sub-total	(60.0)	367,200	(50.0)	306,000	(60.0)	367,200	(50.0)	306,000
2. Rabi								
a. Wheat	(54.0)	330,500	(45.0)	275,400	(34.0)	208,100	(34.0)	208,100
b. Oilseeds	(20.0)	122,400	(17.0)	104,100	(13.0)	79,600	(13.0)	79,600
c. Pulses	(13.0)	79,600	(11.0)	67,300	(8.0)	48,900	(8.0)	48,900
d. Fodders, Misc.	(8.0)	48,900	(7.0)	42,800	(5.0)	30,600	(5.0)	30,600
Sub-total	(95.0)	581,400	(80,0)	489,600	(60.0)	367,200	(60.0)	367,200
Total	(155.0)	948,600	(130.0)	795,600	(120.0)	734,400	(110.0)	673,260

Note: 1/ Cultivable Commanded Area (CCA) is 612,000 acres (100%).
2/ Including fruits and vegetables.

Table IV.3-2 Cropping Types by Profile Salinity Class (Case-3)

(Unit: %, ac)

Type	A	B	C	
Soil Salinity Class	(Non-saline, Non-sodic) Ia	(Slightly Saline) Ib, IIa, IIb, IIc, IIIa, IIIb	(Saline) IIIc, IVa, IVb	Overall
Command Area	214,200 (35.0%)	336,600 (55.0%)	61,200 (10.0%)	612,000 (100.0%)
Kharif				
1. Sorghum	(3.0) 18,400	(6.0) 36,700	(-) -	(9.0) 55,100
2. Rice	(-) -	(14.0) 85,700	(6.0) 36,700	(20.0) 122,400
3. Oilseeds 1/	(9.0) 55,000	(5.0) 30,600	(-) -	(14.0) 85,600
4. Pulses 2/	(4.0) 24,500	(8.0) 49,000	(-) -	(12.0) 73,500
5. Sugarcane	(5.0) 30,600	(-) -	(-) -	(5.0) 30.600
Misc. 3/				
Sub-total	(21.0) 128,500	(33.0) 202,000	(6.0) 36,700	(60.0) 367,200
Rabi				
1. Wheat	(14.0) 85,700	(20.0) 122,400	(-) -	(34.0) 208,100
2. Oilseeds 4/	(2.0) 12,200	(11.0) 67,400	(-) -	(13.0) 79,600
3. Pulses 5/	(3.0) 18,400	(-) -	(5.0) 30,600	(8.0) 49,000
4. Fodders,	(2.0) 12,200	(2.0) 12,200	(1.0) 6,100	(5.0) 30,600
Misc. 6/				
Sub-total	(21.0) 128,500	(33.0) 202,000	(6.0) 36,700	(60.0) 367,200
Total	(42.0) 257,000	(66.0) 404,000	(12.0) 73,400	(120.0) 734,400

Note : 1/ Represented by sunflower.
2/ Soybean (2/3) and others (mungbean, mash, etc., 1/3)
3/ Including fruits and vegetables.
4/ Represented by rapes and mustard.
5/ Represented by gram.
6/ Represented by berseem.

The annual cropping intensity in Case 1, 2, 3 and 4 is 155, 130, 120, and 110 per cent, respectively. The cropping area in the four cases are 948,600 acres (384,900 ha), 795,600 acres (321,900 ha), 734,000 acres (297,200 ha) and 673,200 acres (272,400 ha), respectively. In comparison with the present annual cropped area of 239,600 acres (97,000 ha), the incremental annual cropping area of 718,500 acres (290,800 ha) in Case 1, 556,000 acres (225,000 ha) in Case 2, 494,800 acres (200,200 ha) in Case 3, and 433,600 acres (175,500 ha) in Case 4 will be planted with crops after the completion of the Project.

IV.3.3. Forecast of Food Demand and Production

Food demand and production both in the whole Pakistan and Baluchistan in 2000 are forecasted in selecting the crops to be raised. Judging from the human energy requirements, population growth and food consumption pattern in future, the demand for agricultural products was forecasted, while from the trend of agricultural production increase in the past, an expected quantity of domestic food supply was forecasted. Through a comparison of the demand for agricultural products with the domestic food supply, the necessary agricultural products in the future was forecasted.

1) Food Demand

Food demand was forecasted on the following three items;

i) Human Energy Requirements

From the energy requirements by ages indicated by the intake of the recommended human nutritional requirements by the FAO/WHO and the population composition by age in Pakistan, the average energy requirements of the nation was estimated at 2,600 Kcal.

Table IV.3-3 Food Balance at Present and in Futere

Commodity	Pakistan			Baluchistan		
	Demand in Future (2000) (000 tons)	Domestic Production Level (Demand* = 100) Present (%)	Future (%)	Demand in Future (2000) (000 tons)	Domestic Production Level (Demand* = 100) Present (%)	Future (%)
1. Cereals	34,170	42	78	1,755	17	44
a. Wheat	20,050	48	93	1,030	19	57
b. Rice	9,580	33	66	492	13	31
c. Maize	3,610	23	32	186	2	3
d. Other Cereals	930	74	45	47	62	62
2. Pulses	1,980	35	28	102	6	0
3. Fruit	5,310	42	63	273	94	184
4. Vegetable	7,480	31	31	384	13	102
5. Sugar	3,330	85	165	145	0	1
6. Edible Oil	1,970	8	56	101	18	18
7. Meat	2,540	33	59	130	88	185
a. Beef	510	75	92	26	35	38
b. Mutton	1,710	23	53	88	116	255
c. Poulty	320	16	38	16	19	44
8. Eggs	550	18	55	28	21	64
9. Milk	10,380	87	119	533	241	26
10. Fish	950	31	72	49	129	310

Note: *... Demand in Future = 100

ii) Population Forecast

Based on the population census (1901 - 1981), the population in the whole Pakistan and in Buluchistan was forecasted at 144,000,000 and 7,400,000 in 2000, respectively.

iii) Food Consumption Pattern

The food consumption pattern of by kinds is shown in the Table of Food Demand (1982-1983), the Fifth Five-Year Plan in Pakistan.

2) Food Production

The food production in 2000 was forecasted from the past food production in the country and in Baluchistan as revealed in the agricultural statistics of Pakistan.

3) Balance in Demand and Supply of Food

Forecasting of the balance in demand and supply of food in 2000 has allowed to make a conclusion as follows.

a) The Whole Pakistan

Only milk and sugar will be self-sufficient in 2000 and others will have to be imported. The staple food, wheat, will be nearly self-sufficient. But, the production of rice will be short due to its growing demand, despite that rice is presently an export item.

Regarding the foods to be in short supply, the production of maize, sorghum, barley and other cereals, pulses, vegetables, and poultry will be able to meet only less than 50 per cent of the demand. In addition to the above foods, the demand for rice, fruits, edible oil, mutton and egg will exceed their supply.

b) Baluchistan Province

In Baluchistan Province, the irrigated arable land is insufficient in comparison with the population, and those foods except fruits, vegetables, mutton and fish will have to be imported from the other provinces or from foreign countries. As for the foods in short supply, production of cereals occupies only 44 per cent of the demand. It is necessary, therefore, to increase the production of wheat, rice and other cereals.

IV.3.4. Production of Crops

Table IV.3-3 shows the projected yield and the total crops production in each case in the target year to attain the full benefit of the Project, that is the tenth year after the completion of the Project though it premises that the proposed pilot scheme could properly function in advance to the implementation of the Project. Supporting services like agricultural extension, farm credit, supply of farm input materials and quality seeds and the smooth coordination among various disciplines serving in the Project are the fundamental requirements in attaining the full benefit of the Project.

The method employed in determining the target yield of crops is described in Appendix IV 3.3. From the data on crop yield and nitrogen application, the potential yield of crops with the most optimum and economic nitrogen application was estimated. Based on this potential yield, the target yield of crops in farmers' level was determined for each land class. However, since no experimental data are available on the potential yield of crops under the natural conditions of the Project Area, the potential yield of crops was estimated from data of the other areas. Based on the target yields worked out for each land class and the cropping area of crops in each land class, the weighted average of the potential yield by crops was computed to determine the target yield of them. (See Appendix IV 3-3).

Table IV.3-4 Projected Yield and Total Production (Target Year)

Crop	Target Yield 1/ (ton/ac)	(ton/ha)	Case 1 Area (ac)	Case 1 Production (ton)	Case 2 Area (ac)	Case 2 Production (ton)	Case 3 Area (ac)	Case 3 Production (ton)	Case 4 Area (ac)	Case 4 Production (ton)
1. Kharif										
a. Sorghum	0.445	(1.10)	55,100	24,520	42,800	19,046	55,100	24,520	42,800	19,046
b. Rice	1.578	(3.90)	122,400	193,147	104,100	164,270	122,400	193,147	104,100	164,270
c. Oilseeds (Sunflower)	0.526	(1.30)	85,700	45,112	73,400	38,638	85,700	45,112	73,400	38,638
d. Pulses (Soybean)	0.526	(1.30)	73,400	38,600	61,200	32,191	73,400	38,600	61,200	32,191
e. Others (Sugarcane)	29.017	(71.70)	30,600	887,920	24,500	710,917	30,600	887,920	24,500	710,917
Sub-total			367,200		306,000		367,100		306,000	
2. Rabi										
a. Wheat	1.255	(3.10)	330,500	414,778	275,400	345,627	208,100	261,166	208,100	261,166
b. Oilseeds (Rapes & Mustard)	0.526	(1.30)	122,400	64,382	104,100	54,752	79,600	41,870	79,600	41,870
c. Pulses (Gram)	0.445	(1.10)	79,600	35,422	67,300	29,949	48,900	21,761	48,900	21,761
d. Others	24.322	(60.10)	48,900	1,189,346	42,800	1,040,982	30,600	744,253	30,600	744,253
Sub-total			581,400		489,600		367,200		367,200	
Total			984,600		795,600		734,400		673,200	

Note: 1/ Projected yield for Case 3 is dicided by weighted average by land class (see Appendix).

The target yield per acre of crops in the full development stage is as follows;

Crops	Target Yield
Sorghum	11.9 Mds (1.1 ton/ha)
Paddy	42.2 Mds (3.9 ton/ha)
Kharif oil seeds (Sunflower)	14.1 Mds (1.3 ton/ha)
Kharif pulses (soy bean)	14.1 Mds (1.3 ton/ha)
Sugarcane and others	775.9 Mds (71.7 ton/ha)
Wheat	33.6 Mds (3.1 ton/ha)
Rabi oil seeds (Rapes and mustard)	14.1 Mds (1.3 ton/ha)
Rabi pulses	11.8 Mds (1.1 ton/ha)
Fodder (berseem) and others	650.3 Mds (60.1 ton/ha)

The incremental production is 15,676 tons of sorghum (the target production amounts to about 2.8 times as much as the present production), 167,275 tons (7.4 times) of rice, 42,462 tons (17.0 times) of Kharif oil seeds, 38,600 tons of Kharif pulses, 829,120 tons (15.1 times) of sugarcane and other summer season crops, 197,662 tons (4.1 times) of wheat, 32,078 tons (4.3 times) of Rabi oil seeds, 16,161 tons (3.9 times) of Rabi pulses and 511,597 tons (3.2 times) of fodders and other winter season crops.

Table IV 3-3 shows the total crop production in the four cases.

IV.3.5. Livestock Farming

The livestock farming in the Project Area has played a significant role to supply draft power to farming practices and

animal protein to farmers, to bring the other income than that from crops and to improve the soil property. In general, soils of the Project Area contain limited organic matter in spite that the organic matter is very important for a high yield of crops. The artificial application of organic matter requires a great expenditure. On the other hand, organic matter can be economically obtained through livestock breeding.

Presently the livestock farming in the Project Area is made with a limited feed. After the completion of the Project, domestic animals will be bred with sufficient feed. In formulating the proposed livestock farming plan, attention was paid to the following;

(i) To produce meat and milk equivalent to 125 per cent of their forecast demand in the Project Area in the year 2000. The surplus meat and milk equivalent to some 25 per cent would be exported to neighboring areas.

(ii) To secure two head of bullock and one head of ass per farm household. (The assumed ratio of bullock is four heads of cattle and one head of buffloes).

(iii) To determine the number of cattle and buffloes to be bred for various purposes in the Project Area in consideration of the reproduction of the required number of draft animals mentioned in (ii). The production of meat and milk was estimated from their number so determined. A difference between the forecasted demand of meat and milk and the production would be covered by sheep, goats and poultry.

(iv) Feed would be self-made in the Project Area. By-products of crops and wild grasses would be utilized for livestock farming as much as possible.

According to the proposed livestock farming (see Appendix) the following domestic animals will be raised in the Project Area in future;

Scale of Livestock Farming

(All age)

(Unit: Head)

Animal	Head
1. Cattle	163,000 (Workable, 64,000)
2. Buffaloes	39,600 (Workable, 16,000)
3. Asses	66,500 (Workable, 38,000)
4. Sheep	197,600
5. Goats	120,600
6. Poultry birds	452,000

The demand and supply balance of feed in the TDN and DCP bases is described also in Appendix. The total production of TDN will meet the demand estimated from the livestock farming plan, whereas slight deficiency appears in the DCP base balance. According to the proposed livestock farming plan, 8,400 tons of meat and 33,600 tons of milk could be annually produced after the completion of the Project.

IV.3.6. Forecast of Population and Agricultural Labour Force

The population and agricultural labour force in the Project Area were forecasted as follows.

1) Population

The present total population in the Project Area of about 224,000 is estimated to increase to 420,000 in the target year 2000 from population census (1901-1981), which has been conducted every 10 years.

2) Agricultural Labor Force

As for the statistical data on population composition by

occupations in the Project Area, only the data of Baluchistan Province in 1973 are available. From the data and the forecasted population, the farm population in the Project Area in 2000 was estimated. The estimation shows that the number of agricultural labour force in the Project Area in 2000 will consist of 105,700 full-time labourers and 58,300 part-time labourers. As for labour force available per month, full-time labourer (25-days per month) is counted at 2,650,000 man-days, part-time labourer (10-days per month) at 580,000 man-days, totally 3,230,000 man-days.

Assuming a 30-day working period per month for full-time labourer and a 15-day period per month for part-time labourer, the availability of the former is 3,170,000 man-days and the latter 880,000 man-days, totalling 4,050,000 man-days. Working days over 30 days per month and 15 days per month as above cannot be practically expected. Therefore, 4,050,000 man-days are considered as the maximum labour force available in the Project Area.

IV.3.7. Farm Mechanization and Farm Labour Balance

1) Farm Mechanization

Assuming the future on-farm and farm management conditions in the Project Area after the implementation of the Project, the minimum required farm mechanization has been planned as seen in Appendix in consideration of the following;

(i) To smooth out the peak labour demand specially in October and November when harvesting of Kharif crops and land preparation for Rabi crops overlap;

(ii) To use tractors in deep ploughing for soil improvement;

(iii) To improve the grain quality of cereal crops by mechanical threshing; and,

(iv) To control harmful insects more carefully than present. The control area could be expanded through mechanized spraying.

In principle, the machine-use farming would be limited to the minimum extent, that is, only for supplement to man-power and animal-power. The farm practices for specified crops to be mechanized the area coverage of mechanization and the selected types of machinery are shown below;

Farm Practice, Crops, Area Coverages and Machinery of Farm Mechanization

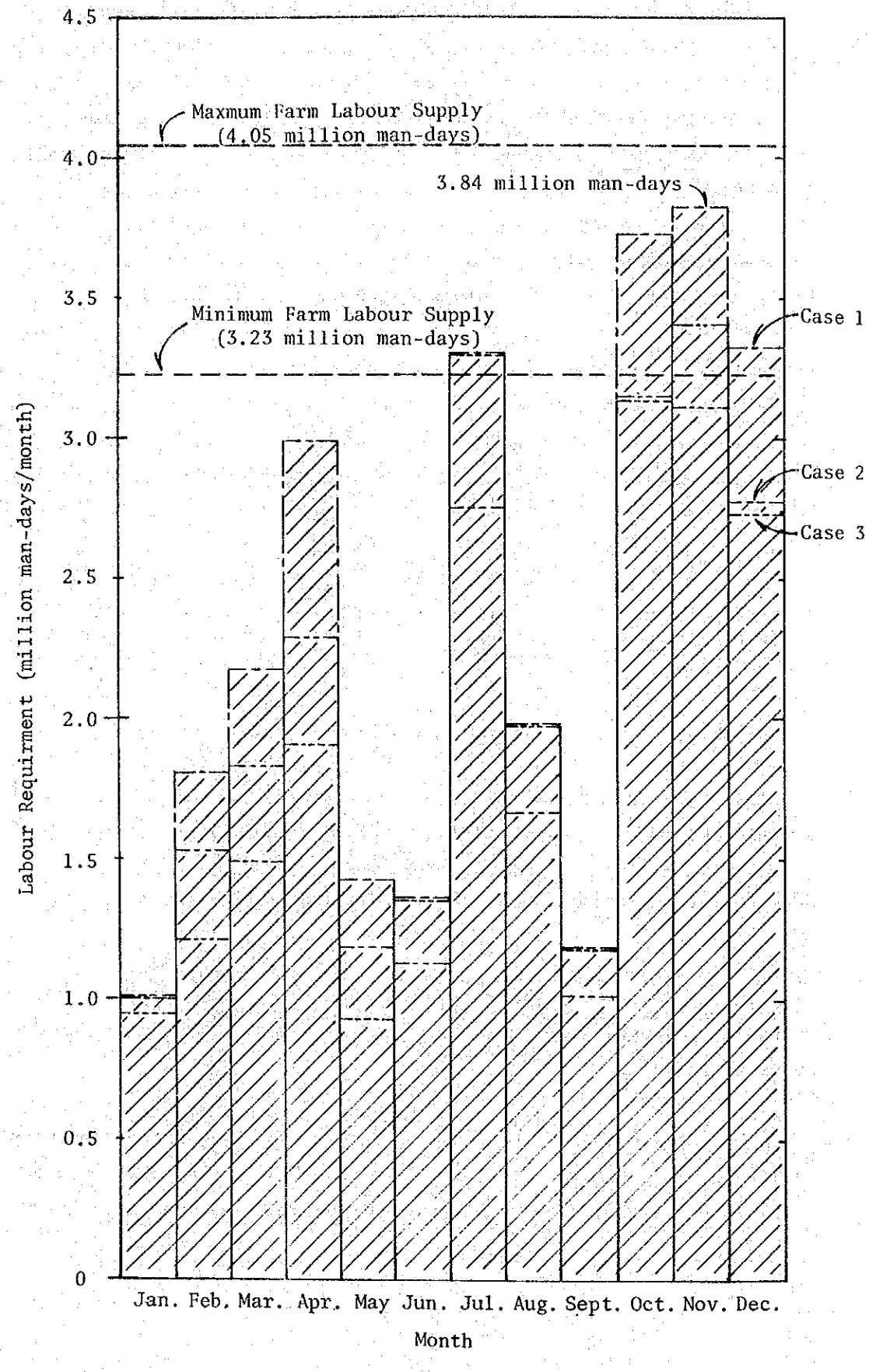
Farm Practices	Crops and Area Coverage	Selected Types of Machinery
1. Land preparation* (Ploughing and Breaking)	All crops (70% of area coverage)	Four-wheel tractor (50 - 60 HP), Plough (16"x3) and Disc harrows (24"x8x2)
2. Threshing	Rice, Wheat, (70% of area coverage)	Power thresher (7 - 8 Throw-in Type, 1.0 ton/hr)
3. Spraying	All crops (70% of area coverage)	Power sprayer (2 - 3 HP 30 lit/min.)

Note: * For the combined use of tractors and draft animals

In relation with the above-mentioned land preparation, the mechanical ploughing and soil breaking will be followed by harrowing by draft animals.

The total number of tractors, power threshers and power sprayers available was estimated at 1,714, 857 and 4,284 in the entire Project Area, respectively. The mechanization cost per acre was computed at

Fig.IV.3-1 Labour Requirement Balance in the Project Area, with Project



approximately Rs. 250 for land preparation (one acre-turn of ploughing plus two acres-turns of soil breaking), Rs. 40 for rice and wheat threshing and Rs. 10 for one acre-turn of spraying.

Except the above-mentioned mechanization, the traditional manual cultivation and farming practices with draft animals would be continued in the remaining 30 per cent of the cropping area after the implementation of the Project.

2) Farm Labour Balance

Based on the forecasted farm labour supply in the year 2000 and the estimated farm labour requirements after the Project implementation, and assuming the above-mentioned farm mechanization, the farm labour balance was computed as shown in Table IV.3-50 of Appendix IV 3-4. The peak demand in November was estimated at 3,118,000 man-days in Case-1, 3,407,000 man-days in Case-2 and 3,118,000 man-days in Case-3 and 2,862,000 man-days in Case-4. On the other hand, the maximum labour supply was estimated at 4,050,000 man-days. The labour supply would be sufficient to meet the peak demand in each case (See Figure IV.3-1). The yearly farm labour demand would be about 4.2 times the present demand in Case-1, 3.5 times in Case-2, 3.4 times in Case-3 and 3.3 times in Case-4. The Project will contribute to create the employment opportunities for inhabitants.

IV.3.8. Farming Practices and Input Material Requirements

The existing constraints in water management could be wiped out through the on-farm facilities development and the establishment of a farmers' organization for operation and maintenance of on-farm facilities. Improvement in farm practices other than the water management would need fertilization, soil management, qualified seeds use, pest control, and line planting, etc. Special attentions should be paid to the timely introduction of modernized farming practices

along with the progress of the construction works under the Project. For this purpose and also for the extention of on-farm water management technology, the implementation of a Pilot Project is proposed (See Section IV.5 "Pilot Project").

In order to estimate the required labour and input materials, the farming practices for respective crops are assumed as shown in Tables IV 3-52 to 3-60 of Appendix IV 3-5. The input materials required per acre such as seeds, chemicals, fertilizers and insecticides, etc. and also their total requirements in the Project Area are shown in Table IV 3-51 of Appendix IV 3-5.

As for wheat and rice, about 1,800 tons and 500 tons of certified seeds would be annually required in the Project Area in Case-3 if the seeds of both crops are renewed every four years. A certified seed supply system should be established not only for wheat and rice but also for the other crops to be raised in the Project Area.

The chemical fertilizers required on the nutrient amount basis are nitrogen of about 25,100 tons, phosphate of 20,900 tons and potassium of 3,300 tons in Case-3.

In addition, insecticides of about 900 tons and herbicides of 100 kilo littres would be necessary. The total amount of necessary chemical fertilizers is about eight times as much as the amount consumed in 1980/81.

IV.3.9. Farmers' Organization

All the beneficial farmers would participate in the Water Users' Association (WUA) as members to ensure the following;

i) To offer unskilled labour free of charge for the construction and operation and maintenance of on-farm facilities;

ii) To collect water charges from the members and pay these to the Government; and,

iii) To make the members accept farm practices which would lead to a high water use efficiency and to an increase in agricultural production.

The rotational irrigation would be carried out in each irrigation rotation area of about 80 acres on an average. The Water User's Group(WUG) would be established as a sub-unit of the WUA in each irrigation area. About four to five WUGs of which cultivation lands are commanded by one main water course is called "chak".

At the chak level, the WUGs under a chak would organize the Chak Water Users' Association (CWUA). The CWUA would be responsible for the development and operation and maintenance of on-farm facilities within the chak. The CWUAs will organize the WUA. The WUA would employ necessary staff to establish the main and branch offices for its activities. A branch office of the WUA could be established in each jurisdiction of a sub-divisional office (O & M Office of the Project Facilities)

Field Assistants and Agricultural Officers in village level and Union Council level, respectively, would be responsible for the establishment of the above-mentioned farmers' organizations and for rendering sufficient extension services.

IV.3.10. Agricultural Supporting Services

1) Extension

The present agricultural extension services should be substantially strengthened to achieve the targets under the Project. It would be of vital importance to secure the adequate number of qualified staff, to provide the staff with transportation means and

housing, to let them undergo necessary education and trainings such as the continuous in-service education, farmer's problems-oriented trainings and trainings on improved farm practices.

The following organizational arrangement could be proposed for strengthening extension services;

i) About 125 extension workers named "Field Assistant" would be assigned to the Project Area. One Field Assistant would be responsible for extension services for about 500 households or 5,000 acres of cultivation lands which is equivalent to the typical village size. In other words, one Field Assistant is assigned at village level.

ii) One Agriculture Officer will be posted to each Union Council which consists of about five villages. The Project Area will have about 25 Union councils.

iii) A posting station called "Village Officer" in this report will be established for each Union Council under the Project. Therefore, about 125 Field Assistants will render their services in 25 Union Councils under the supervision of 25 Agriculture Officers.

iv) To make smooth coordination between the officials in charge of agricultural extension and on-farm water management development and those in charge of operation and maintenance of the Project facilities, one Agriculture Officer will be assigned to "Sub-divisional Office", which is an office for operation and maintenance of irrigation facilities, and responsible for the supervision of extension services as well as for coordination between the extension services and operation and maintenance in the sub-division level.

v) The following three committees will coordinate the activities of various agencies and organizations related to the Project;

Level	Name of Committee
1. Area covered by a Sub-division Office, nearly equivalent to Tehsil level	Technical Committee
2. District level (Nasirabad)	Joint Committee
3. Division level (Sibi)	Coordinating Committee

vi) To provide Agriculture Offices with such equipment as vehicles and audio-visual equipment under the Project or Pilot Project.

2) Research

No agricultural research activities have been carried out in the Project Area and its vicinity until now except yield tests of limited crops. Specially, an agricultural research in respect of specified soils has not been made yet. Under the circumstances, no scientific data on modernized agricultural techniques are available. Farming practices are made by traditional methods, and farmers have no experience in modernized agricultural techniques. It is most desirable that experimental results and local farming experience in each soil type could be combined to establish an optimum farm management system.

In consideration of those mentioned above, the system to identify farmers' problems and to obtain the solution through "Action Research" should be introduced as soon as possible. Extension workers shall perceive and understand the problems that farmers are

facing, and report to researchers and feed back to farmers the measures for solution indicated by the researchers. A strong link would be necessary between the extension and research activities for the following;

- ° Identification of existing problems at farmers' level;
- ° Development of solutions for the problems;
- ° Assessment of the solutions;
- ° Pilot study on the solutions and evaluation;
- ° Demonstration and extension activities for the educations in the entire Project Area.

To initiate these activities in the Project Area, a Pilot Project is proposed to be implemented. (see IV.5 Pilot Project) The Pilot Project would function to practically demonstrate multi-purpose activities inclusive of the "Action Research".

It has been planned that the Agricultural Research Institute at Sariab near Quetta will establish a new branch institute at Dera Murad Jamli to render research services to the Project Area and vicinity. It is expected that this plan will be realized as soon as possible so that the branch would support the extension services in the Project Area and carry out the comprehensive research necessary for the irrigated agriculture in the Project Area. The following technology will be prerequisite for the development of the irrigated agriculture in the Project Area.

- ° Measures for rapid raise of soil potential;
- ° Development of salt tolerant varieties of crops;
- ° Determination of the composition and level of soil nutrient needed for obtaining the optimum yield of crops;
- ° Practices for the use of water at different quantities for obtaining the optimum yield of crops;
- ° Water-logging and salinity control measures; and,
- ° Establishment of suitable drainage system and technology.

IV.4. Proposed Facilities

IV.4.1. Guddu Barrage Head Regulator

Guddu Barrage was constructed on the Indus River at Guddu in 1963 from which a head regulator diverts a design discharge of 13,139 cusec (371.8 cu.m/sec) to Desert Pat Feeder Canal on the right bank of the Indus to irrigate farm lands in Sind and Baluchistan Provinces. Although PC-1 prepared in 1979 estimates the intake discharge at 17,100 cusec (483.9 cu.m/sec) when the pond level is 255.5 feet, the present intake discharge computed by the survey team is 17,300 cusec (489.1 cu.m/sec) on the assumption that a head loss is constantly kept at 0.8 feet.

In releasing a design discharge of 17,500 cusec (495.3 cu.m/sec) in Case-1 & Case-3 to the Desert Pat Feeder Canal, a head loss of 0.05 feet at the head regulator of Guddu Barrage should be increased to 0.85 feet. It is a negligible small increase in head loss, however, the necessary head loss at the upstream most of the Desert Pat Feeder Canal should be kept by 0.05 feet lower than the the original designed water level.

IV.4.2. Desert Pat Feeder Canal

The existing Desert Pat Feeder Canal with 7.0 miles (11.3 kms) in length, 15.5 ft (4.72 m) in water depth and 240 ft (73.2 m) in bed width has a capacity of 13,748 cusec (389.1 cu.m/sec) and from the end of this canal, Desert Canal and Pat Feeder Canal diverge to irrigate farm lands in Baluchistan and Sind Provinces.

Widening of the Desert Pat Feeder Canal would be made by such manner that the right bank of the canal will be moved to have a canal bed width of 285 ft (86.87 m) with a water depth of 15.5 ft (4.72 m) and a hydraulic gradient of 1:15,000 as estimated in PC-1.

Only its right bank can be moved since Begari Sind Feeder Canal running along the left bank of this canal obstructs the expansion of the canal towards left.

IV.4.3. Pat Feeder Canal

Widening of the existing canal between RD 0 and RD 586 will be made, and the canal will newly be extended up to RD 624. The Pat Feeder Canal has a total length of 118.20 miles (190.20 kms) with a designed discharge of 11,000 to 1,960 cusec (311.3 to 55.47 cu.m/sec) in Case-1 and Case-3 and 9,500 to 1,602 cusec (268.9 to 45.3 cu.m/sec) in Case-2.

1) Full Supply Level and Bed Level

Taking into consideration the existing canal structures such as head regulator, cross regulator and offtake, the proposed full supply level is designed to keep a differential of one tenth of foot in comparison with the present one while the elevation of the bed level is kept with a differential of one foot from the present level.

Hydraulic calculation for the canal is shown in the Appendix.

2) Canal Section

As mentioned previously, canal should satisfy the relationship among the depth of water and bottom-width, side slope, freeboard and width of the bank top.

a) Water-depth and Bed-width

The rotation of bed-width and depth at eight has been adopted as a standard for large canals located on a relatively level ground in consideration of the balance of cut and fill. However, this standard cannot be applied to the Pat Feeder Canal due to its condition as discussed in the former paragraph.

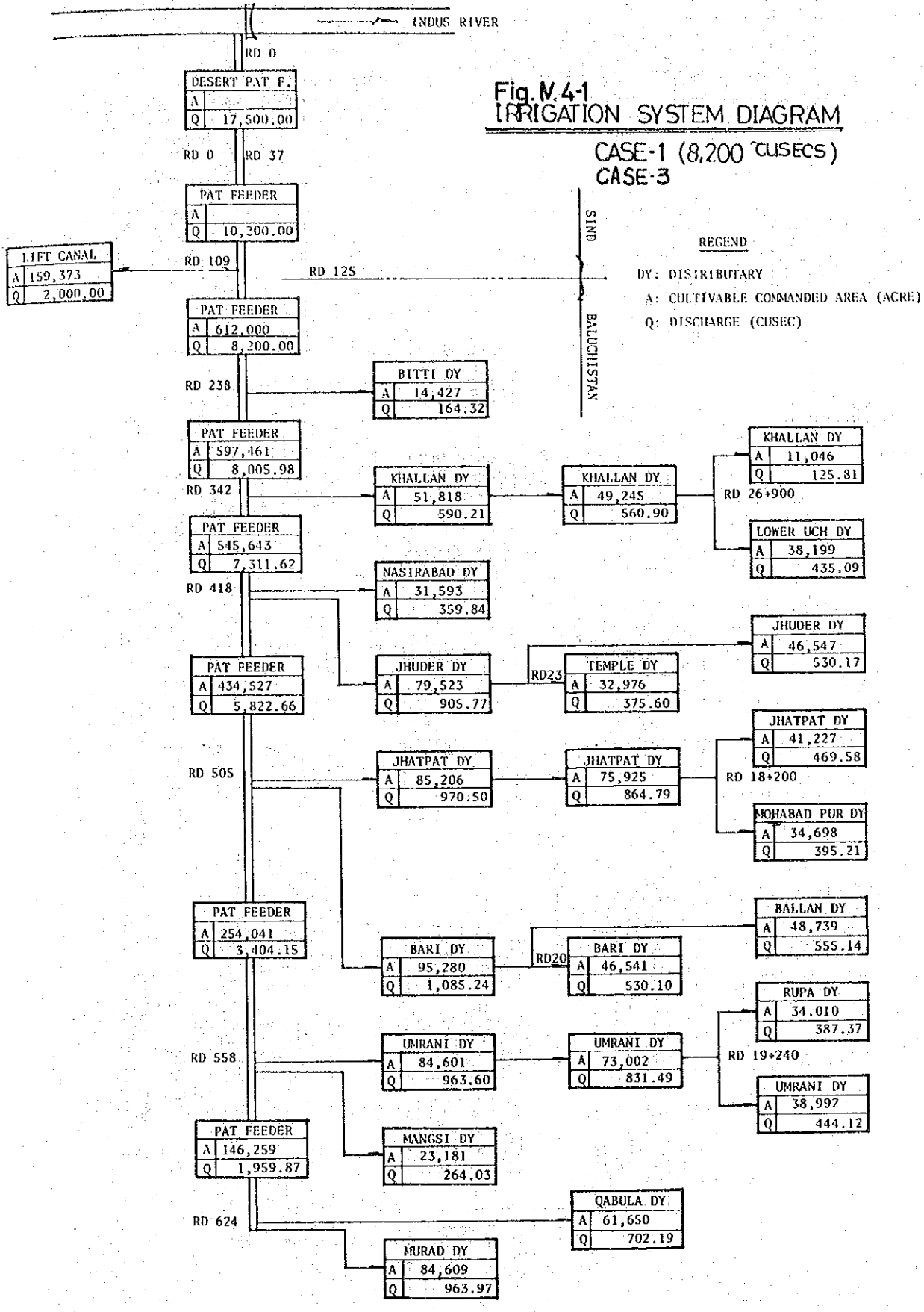


Fig. N. 4-1
IRRIGATION SYSTEM DIAGRAM

CASE-1 (8,200 CUSECS)
CASE-3

REGEND

DY: DISTRIBUTARY
A: CULTIVABLE COMMANDED AREA (ACRE)
Q: DISCHARGE (CUSEC)

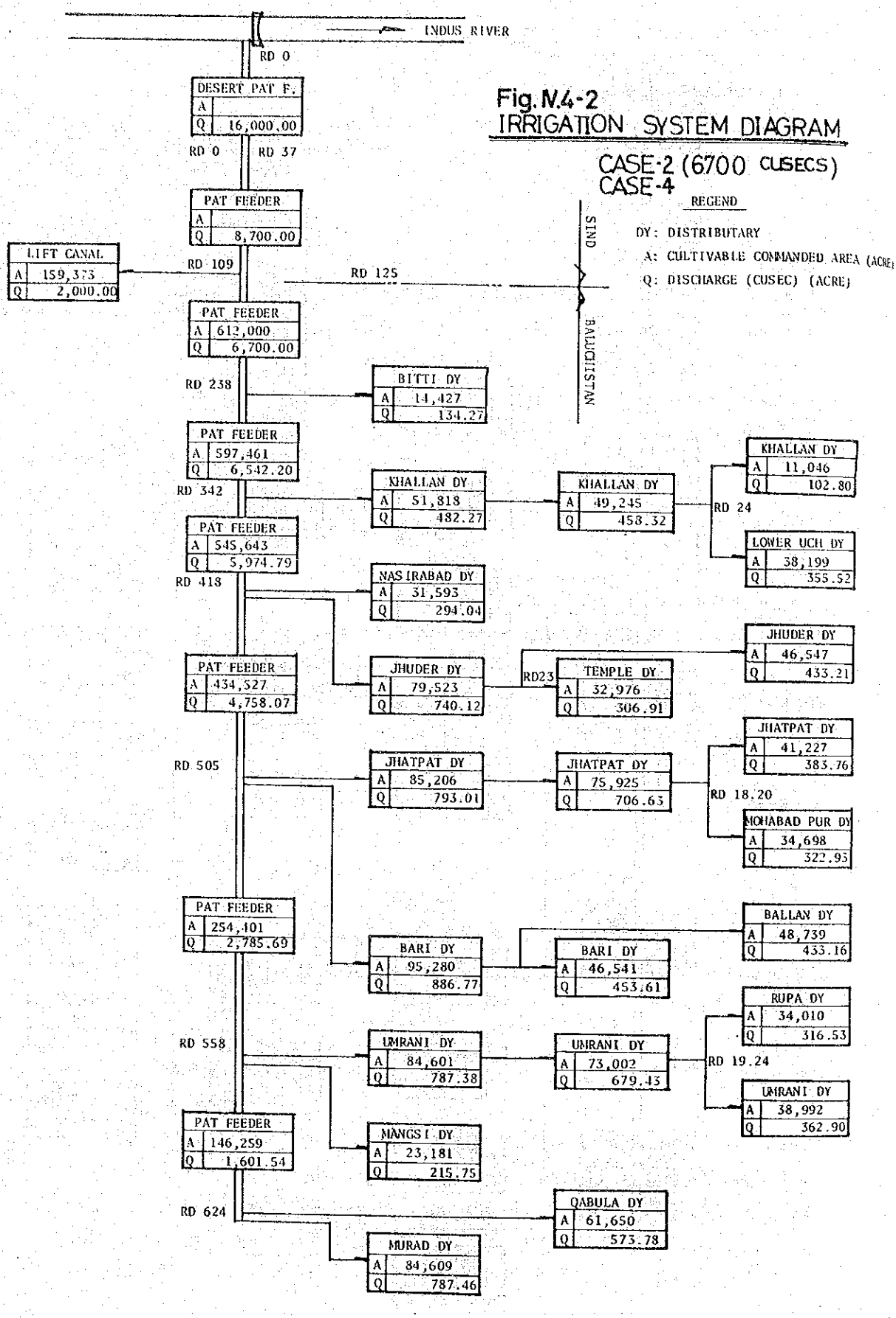


Fig. M.4-2
IRRIGATION SYSTEM DIAGRAM

CASE-2 (6700 CUSECS)
CASE-4

REGEND

DY: DISTRIBUTARY
A: CULTIVABLE COMMANDED AREA (ACRE)
Q: DISCHARGE (CUSEC) (ACRE)

Table IV.4-1 Hydraulic Section of Desert-Pat & Pat Feeder Canal (Case 1)

Type of Canal	Discharge Q(cusecs)	Bed Width B(feet)	Water Depth D(feet)	Area of Section (sq.feet)	Wetted Perimeter (feet)	Hydraulic Gradient	Mean Velocity V(feet/sec)	Silt Critical Verocity Vo(feet/sec)	V/Vo
MA-1	17,500	285.0	15.5	4,658	328.8	1/15,000	3.77	3.88	0.97
MA-2	11,000	235.0	13.0	3,224	271.8	1/14,000	3.41	3.46	0.99
MA-3	5,823	170.0	10.5	1,895	199.7	1/12,400	3.07	3.03	1.01
MA-4	3,405	120.0	9.0	1,161	145.5	1/10,500	2.93	2.74	1.07
MA-5	1,960	85.0	8.0	744	107.8	1/ 8,800	2.87	2.54	1.13
MB-1	8,200	193.0	12.0	2,604	246.7	1/13,700	3.16	3.09	1.02
MB-2	8,006	188.0	12.0	2,544	241.7	-do-	3.15	-do-	1.02
MB-3	7,312	182.0	11.5	2,358	233.4	1/13,200	3.12	3.01	1.04
LB-1	8,200	155.0	12.0	2,148	208.7	1/15,000	3.83	3.30	1.16
LB-2	8,006	151.0	12.0	2,100	204.7	-do-	3.82	-do-	1.16

Note: MA- ; Side slope m = 1:1
MB- ; Side slope m = 2:1
LB- ; Lined canal, Side slope m = 2:1
LA- ; Lined canal, Side slope m = 1:1

Table IV.4-2 Hydraulic Section of Desert-Pat & Pat Feeder Canal (Case 2)

Type of Canal	Discharge Q(cusecs)	Bed Width B(feet)	Water Depth D(feet)	Area of Section (sq.feet)	Wetted Perimeter (feet)	Hydraulic Gradient	Mean Velocity V(feet/sec)	Silt Critical Velocity Vo(feet/sec)	V/Vo
MA-1	16,000	260.0	15.5	4,270	303.8	1/15,000	3.74	3.88	0.96
MA-2	9,500	205.0	13.0	2,834	241.8	1/14,200	3.36	3.46	0.97
MA-3	4,758	140.0	10.5	1,580	169.7	1/12,600	3.00	3.03	0.99
MA-4	2,786	100.0	9.0	981	125.5	1/10,500	2.88	2.74	1.05
MA-5	1,602	65.0	8.0	584	87.8	1/ 8,800	2.79	-do-	1.02
MB-1	6,700	158.0	12.0	2,184	211.7	1/14,000	3.07	3.09	1.00
MB-2	6,542	154.0	12.0	2,136	207.7	-do-	3.07	-do-	1.00
MB-3	5,945	145.0	11.5	1,932	196.4	1/13,000	3.08	3.01	1.02
LB-1	6,700	127.0	12.0	1,812	180.7	1/15,500	3.70	3.30	1.12
LB-2	6,542	124.0	12.0	1,776	177.7	-do-	3.69	-do-	1.12

Note: MA- ; Side slope $m = 1:1$

MB- ; Side slope $m = 2:1$

LB- ; Lined canal, Side slope $m = 2:1$

LA- ; Lined canal, Side slope $m = ?:1$

Table IV.4-3 Bed Width of Pat Feeder Canal

	Reach RD	Present Capacity (cusec)	Case 1 Case 3 (8,200) Required Capacity (cusec)	Case 1 Case 3 (8,200) Required Bed Width (ft)	Case 2 Case 4 (6,700) Required Capacity (cusec)	Case 2 Case 4 (6,700) Required Bed Width (ft)
Desert Pat Feeder	0- 37	13,640	17,500	285	16,000	260
Pat Feeder	0-104	4,000	11,000	235	9,500	205
	104-109	6,700	11,000	235	9,500	205
	109-116	5,680	8,200	193	6,700	158
	116-190	3,700	8,200	193	6,700	158
	190-238	5,680	8,200	193	6,700	158
	238-342	5,126	8,006	188	6,542	154
	342-418	4,546	7,312	182	6,542	154
	418-505	2,801	5,823	170	4,758	140
	505-558	1,929	3,405	120	2,786	100
	558-586	582	1,960	85	1,602	65
	586-624	-	1,960	85	1,602	65

b) Side Slope

The side slope of the Pat Feeder Canal from RD 418 to RD 558 is satisfactorily kept at 1:1, while the embankment material of this canal from RD 109 to RD 428 is fine sand, so that the original side slope of 1:1 could not be kept, and is stable at 1.8:1 to 2.0:1. In consideration of the general conceptions discussed in "Open Channel Hydraulics", a side slope of 1:1 from RD 0 to RD 109 and from RD 418 to RD 558 and a side slope of 2:1 from RD 109 to RD 418 are designed.

c) Berm Width

For Pat Feeder Canal, a service road or an operation and maintenance road with a top width of 25 feet and a shoulder of three feet at the left bank of the canal is designed while at the right bank of the canal, the construction of a berm with a top width of 20 feet and six feet higher than FSL is scheduled.

d) Freeboard

The freeboard of a canal is usually designed empirically. Although the freeboard is affected by the size of a canal, the inflow of flood into the canal, and the movement of water surface, etc., the freeboard is generally determined at 5 to 30 per cent of the depth of the channel. On the other hand, the freeboard ranges from one foot for a small size canal to four feet for a large scale canal with a discharge of 3,000 cusec (84.9 cu.m/sec) or more.

Taking into consideration the safety of both dikes of the canal, the originally designed freeboard of three feet is applied.

e) Embankment of Berm

The berm with a side slope of 2:1 at the left bank should be sufficiently compacted for traffic use while that of the right bank

would be formed to have a side slope of 3:1 in consideration of a relatively high embankment with rough compaction.

Where the Pat Feeder Canal has high embankment and the canal bottom is higher than the natural ground level, a gentle slope of 3:1 and five feet steps at every 10 feet height are proposed for the embankment.

3) Canal Lining

Due to sandy materials and very high embankment, the leakage of water through the canal embankment was observed between RD 185 and RD 320. To reduce the seepage and to prevent erosion of the side slopes of the canal, brick lining with a total length of 42,000 feet (12.8 km) from RD 185 to RD 190, from RD 224 to RD 235 and from RD292 to RD318 is proposed. In addition, brick lining from RD 488 + 970 to RD 489 + 090 is also proposed for strengthening the railway abutment.

4) Planting

Fine sandy materials are used for the canal embankment between RD 109 and RD 418, and the eroded materials and sediments entered into the canal, hindering the flow of the canal. It is proposed to plant shrub or to sod on the both side of the canal embankment. After planting or sodding, it will be necessary to irrigate them sometimes until their rooting.

IV.4.4. Distributaries

The construction of most distributaries have been completed to irrigate farm lands. A study on capacities and functions of the existing canal structures, such as regulators and plain falls etc., has revealed that all distributaries except Mohabatpur and Rupa distributaries should be widened. At the downstream most of the Pat Feeder Canal, two distributaries, Qabula and Murad should be newly

Table IV.4-4 Length, Discharge & Commanded Area of Distributaries

Name Distributary	Off-take Point	Length of Disty (miles)	Length of Disty (kirometers)	Proposed Discharge at Head (cusecs) Case 1 (8,200)	Proposed Discharge at Head (cusecs) Case 2 (6,700)	Culturable Commanded Area (C.C.A) (acres)
I. Baluchistan Province						
A. Phase-I (Gravity Flow Canal)						
1. Bitti	RD 238+000 Pat Feeder	15.91	25.60	164.32	134.27	14,427
2. Khallan	RD 342+000 "	9.09	14.63	155.12	126.75	13,619
3. Lower Uch	RD 26+900 Khallan	10.04	16.16	435.09	355.52	38,199
4. Nasirabad	RD 413+000 Pat Feeder	11.12	17.90	359.84	294.04	31,593
5. Jhudher	RD 413+000 "	18.79	30.24	530.17	433.21	46,547
6. Temple	RD 23+000 Jhudher	16.06	25.85	375.60	306.91	32,976
7. Jhatpat	RD 503+000 Pat Feeder	16.57	26.67	575.29	470.08	50,508
8. Mohabat pur	RD 18+200 Jhatpat	14.26	22.95	395.21	322.93	34,698
9. Bari	RD 505+000 Pat Feeder	22.63	36.42	530.10	433.16	46,541
10. Ballan	RD 20+000 Bari	17.52	28.19	555.14	453.61	48,739
11. Umrani	RD 558+000 Pat Feeder	16.29	26.22	576.23	470.85	50,591
12. Rupa	RD 19+240 Umrani	12.12	19.50	387.37	316.53	34,010
13. Mangsi	RD 558+000 Pat Feeder	13.01	20.94	264.03	215.75	23,181
14. Qabula	RD 624+000 Pat Feeder	17.99	28.95	702.19	573.78	61,650
15. Murad	RD 624+000 "	25.57	41.14	963.97	787.46	84,609
	Total	236.97	381.36	6,970	5,695	611,888
B. Phase-II (Lift-cum-gravity Flow Canal)	RD 109+000 Pat Feeder			2,000	2,000	159,373
	G.Total			8,970	7,695	771,261

constructed to irrigate the extension area under the Project.

The total length of 15 distributaries is 236.97 miles (381.4 km) as shown in Table IV.4-4.

1) Canal Section

The section of distributaries is determined to have almost the same bed width as the existing ones and a water depth of less than one foot deeper than the existing one, to the maximum extent possible in considering the economics.

Bitti and Khallan distributaries are designed to have a side slope of 2:1 in consideration of their embankment materials of fine sandy soil while the other distributaries to have a side slope of 1:1.

Freeboard of the embankment will be 2.0 feet at the left bank and 2.5 feet at the right bank, and the side slope of the embankment will be 2:1.

The berm width at the right bank is designed to be the same as the existing one, however, the width of the left bank will be 20 feet of which 10 feet width would be paved with gravels in order to utilize it as a service road for operation and maintenance and for general traffic.

2) Full Supply Level

The full supply level of distributaries should be kept as high as possible in order to divert water to minor Canals. For the period of low water level, water of distributaires will be checked up by the stop-log accommodated at plain fall and bridge.

IV.4.5. Minor Canals

The design and alignment of minor canals were made based upon survey and study results on the existing on-farm facilities in the Sample Area. The Sample Area was selected for comparatively detailed study on the existing irrigation and on-farm facilities and for establishing a recommendable development scheme.

As discussed in Paragraph III.4.3 , the size of an irrigation block commanded by an outlet (Chak) is too large to carry out the modern irrigated agriculture with proper water management, and the length of a water course is too long, resulting much water losses.

Improvement in the alignment of irrigation network shall be made firstly to have a proper canal intensity and secondly to realize an adequate chak size. For the improvement of the canal intensity, instead of distributaries, the construction of minor canals is proposed. The minor canals will be diverged from a distributary through the offtake, constant head orifice turnout (double gated), by rehabilitating a part of the water course or by newly constructing it between the distributaries. The minor canals so constructed will contribute to shortening the length of a water course and reducing the commanded area by a Chak.

According to the results of the study on the Sample Area, the proposed intensity of minor canals is 6.7 feet per acre (5.0 meter per ha) commanding a cultivable area of 2,223 acres (899.6 ha).

IV.4.6. Canal Structures

Canal structures consist of head regulators, cross regulators, plain falls, cross drainage and offtakes, and the most structures would be improved for the widening programme. In addition to the improvement, some canal structures will be newly constructed. The design of new canal structures was made based on the prevailing criteria for use of local materials.

1) Regulator

Cross regulators of the main canal would be extended in length to the right bank of the canal. One gate is 10 feet in width, for reference.

As for the distributaries, Umrani head regulator would be extended in both Case-1 and Case-2 and the other head regulators will not be changed. In addition to the existing ones, head regulators would
newly be constructed for Qabula, Murad and Lower Uch.

2) Plain Falls

The existing plain falls would be improved. The plain falls will be equipped with stop-logs to control the water surface of distributaries.

Some plain falls are newly proposed for the distributaries made with brick and reinforced concrete. They will be the drop type falls with a water way of six feet in width taking into consideration convenience of the operation by stop-log.

3) Cross Drains

The Qabula Rive runs across the Pat Feeder Canal at RD 610, therefore, a reinforced concrete box culvert with 15 ft x 24 ft x 4 bays is proposed. The appurtenant wall and others will be made with brick and reinforced concrete.

4) Offtakes

The constant head orifice turnout (double gated) is proposed to measure and control effectively the flow from distributaries to minor canals.

Table IV. 4-5 Widening Plan of Head Regulators

Name	Off-take-point	Existing Size	Proposed Widening Case 1 (8,200 cusecs)	Proposed Widening Case 2 (6,700 cusecs)
Desert Pat Feeder	Guddu Barrage	24' x 9 = 216'	none	none
Pat Feeder	Desert Pat Feeder	10' x 11= 110'	10' x 4 = 40'	none
Bitti	Pat Feeder	8' x 2 = 16'	none	none
Khallan	"	8' x 3 = 24'	"	"
Nasirabad	"	6.5' x 3 = 19.5'	"	"
Jhudher	"	8' x 4 = 32'	"	"
Jhatpat	"	10' x 4 = 40'	"	"
Bari	"	10' x 4 = 40'	"	"
Umrani	"	8' x 3 = 24'	8' x 2 = 16'	8' x 1 = 8'
Mangsi	"	8' x 2 = 16'	none	none
Qabula	"	-	8' x 4 = 32'	8' x 3 = 24'
Murad	"	-	8' x 5 = 40' (Remould)	8' x 4 = 32' (Remould)
Lower Uch	Khallan Distry	6' x 3 = 18'	8' x 3 = 24'	8' x 2 = 16
Temple	Jhudher Distry	8' x 3 = 24'	none	none
Mohabat pur	Jhatpat Distry	8' x 3 = 24'	"	"
Ballan	Bari Distry	8' x 3 = 24'	"	"
Rupa	Umrani Distry	10' x 2 = 20'	"	"

Table IV. 4-6 Widening Plan of Cross Regulators

Name	Station	Existing Size	Proposed Widening Case 1 (8,200 cusecs)	Proposed Widening Case 2 (6,700 cusecs)
A. Par Feeder Canal				
Par Feeder	RD 109	10' x 11 = 110'	10' x 5 = 50'	10' x 1 = 10'
	RD 283	10' x 11 = 110'	10' x 5 = 50'	10' x 2 = 20'
	RD 342	10' x 10 = 100'	10' x 5 = 50'	10' x 2 = 20'
	RD 418	10' x 9 = 90'	10' x 4 = 40'	10' x 1 = 10'
	RD 505	10' x 6 = 60'	10' x 3 = 30'	10' x 2 = 20'
	RD 558	10' x 4 = 40'	10' x 3 = 30'	10' x 2 = 20'
B. Distributaries				
Khallan	RD 26.90	6' x 2 = 12'	8' x 1 = 8' (Remould)	8' x 1 = 8' (Remould)
Jhudher	RD 23.00	8' x 4 = 32'	none	none
Jhatpat	RD 18.20	8' x 3 = 24'	none	none
Bari	RD 20.00	8' x 3 = 24'	none	none
Umrani	RD 19.24	10' x 2 = 20'	none	none

Table IV. 4-7 List of Plain Falls along Distributaries

Name of Disty	Station	Case 1 (8,200) cusecs Discharge	Fall	Case 2 (6,700) cusecs Discharge	Fall	Remarks
1. Bitti	RD 46.72	47.95	3.00	39.20	3.00	Proposed
	50.50	47.95	4.00	39.20	3.50	Proposed
	53.50	40.57	3.00	33.18	3.00	Proposed
2. Kallan	RD 40.20	60.37	4.00	49.32	4.00	Proposed
3. Lower Uch	RD 2.00	435.09	7.00	355.52	7.00	Remould
	4.00	435.09	7.00	355.52	7.00	Remould
	8.00	428.00	7.00	349.72	7.00	Remould
4. Nasirabad	RD 7.60	291.82	3.50	238.46	3.50	Remould
	10.90	255.84	4.50	209.06	4.50	Remould
	16.00	210.17	3.00	171.75	3.00	Remould
	22.00	167.34	4.00	136.75	3.60	Remould
	30.40	97.36	3.00	79.57	3.00	Remould
5. Jhudher	RD 29.37	453.01	3.00	370.17	3.00	Proposed
	34.40	402.19	3.00	328.65	3.00	Remould
	52.93	288.78	3.00	235.98	3.00	Remould
	60.91	239.90	2.00	196.05	2.00	Remould
	69.93	190.13	4.00	155.38	3.60	Remould
	78.67	142.24	4.00	116.22	4.00	Remould
	89.66	83.60	3.00	68.31	3.00	Remould
6. Temple	RD 33.52	258.58	3.00	211.30	2.50	Remould
	45.50	166.87	4.00	136.35	4.00	Remould
	67.74	61.35	4.50	50.13	4.10	Remould
	76.17	29.17	2.00	23.84	2.00	Remould

to be continued

Name of Disty	Station	Case 1 (8,200) cusecs Discharge	Fall	Case 2 (6,700) cusecs Discharge	Fall	Remarks
7. Jhatpat	RD 9.90	882.37	2.50	720.99	2.50	Remould
	27.10	427.47	3.00	349.30	2.70	Remould
	40.00	350.13	2.50	286.11	2.50	Remould
	51.84	271.69	1.50	220.01	1.50	Proposed
	61.50	204.41	2.00	267.03	2.00	Remould
	69.90	102.91	3.50	84.09	3.50	Remould
8. Mohabatpur	RD 3.90	353.89	2.00	289.17	2.00	Remould
	19.30	299.57	3.00	244.78	2.50	Remould
	30.90	238.50	2.00	194.88	2.00	Remould
	43.60	159.64	2.00	130.43	2.00	Remould
	54.50	72.22	2.00	59.00	2.00	Remould
	67.00	22.56	2.00	18.43	2.00	Remould
9. Bari	RD 40.00	468.23	2.50	382.61	2.50	Remould
	59.00	381.63	3.00	311.85	3.00	Remould
	70.00	312.39	4.00	255.30	3.50	Remould
	80.00	243.23	3.00	198.79	3.00	Remould
	90.00	200.97	2.00	164.26	2.00	Remould
	105.00	106.38	3.00	86.97	3.00	Remould
10. Ballan	RD 11.00	469.59	2.00	383.70	2.00	Remould
	24.00	385.05	3.50	314.64	3.50	Remould
	37.00	335.79	3.00	274.40	3.00	Remould
	49.00	274.17	4.00	224.06	4.00	Remould
	57.00	212.27	3.50	173.49	3.00	Remould
	66.50	143.49	1.50	117.29	1.50	Remould
	80.20	61.09	1.00	49.96	1.00	Proposed

to be continued

Name of Disty	Station	Case 1 (8,200) cusecs Discharge	Fall	Case 2 (6,700) cusecs Discharge	Fall	Remarks
11. Umrari	RD 9.68	898.60	3.40	734.26	3.40	Remould
	31.47	386.81	1.00	316.07	1.00	Proposed
	45.17	318.99	2.00	260.64	2.00	Remould
	59.00	197.77	5.00	161.58	4.50	Remould
	69.26	116.86	5.00	95.47	5.00	Remould
	79.36	31.56	5.00	25.78	5.00	Remould
12. Rupa	RD 9.40	344.08	3.00	281.55	3.00	Remould
	17.30	286.24	4.00	233.89	4.00	Remould
	27.00	288.99	4.00	187.10	4.00	Remould
	41.80	135.86	2.00	111.00	1.80	Remould
13. Mangsi	RD 40.00	171.63	2.00	140.24	1.70	Remould
	50.00	85.83	3.00	70.13	3.00	Remould
14. Qabula	RD 19.02	560.99	2.00	458.41	2.00	Proposed
	28.02	492.00	2.00	402.06	2.00	Proposed
	38.02	428.67	2.00	350.31	2.00	Proposed
	49.02	343.74	3.00	280.89	3.00	Proposed
	59.02	246.37	3.50	201.34	3.00	Proposed
	71.02	148.56	3.50	121.42	3.50	Proposed
	86.02	43.70	2.00	35.73	2.00	Proposed
15. Murad	RD 20.02	892.50	2.00	729.08	2.00	Proposed
	40.02	812.12	3.00	663.39	2.50	Proposed
	60.02	658.42	2.00	537.84	2.00	Proposed
	80.02	513.62	2.50	419.57	2.50	Proposed
	100.02	369.27	2.50	301.66	2.50	Proposed
	115.02	263.27	2.50	215.06	2.50	Proposed
	127.52	96.34	2.00	78.71	2.00	Proposed

IV.4.7. Roads and Bridges

1) Road Network

Traffic system in the Project Area, which consists of road networks and road bridges, is very poor. Across the center of the Project Area, National Road connecting Quetta,Sibi,Jhatpat, and Karachi runs from north to south. In addition, the other national roads connecting Jhatpat and Usta Mohammad function as a trunk road in the Area. Service roads along the main canals and distributaries, together with the above mentioned two national, roads are only traffic system available in the Project Area. The national roads are paved with metal, whereas the others are slippery clayey roads. For about a week after a rain passes, the said clayey roads are not available for traffic.

After the development of the Project, the traffic volume in the Project Area would extremely increase due to the incremental agricultural input and output. In addition to the two national roads, the service roads along the main canal would be improved to be metalled roads with 20 ft width of asphalt pavement in a distance of 73.3 miles (118 km) from RD 238 to RD 625.

Service roads along distributaries, 217 miles (349.2 km) in length, and connecting roads between the ends of each distributary and the national road, 35 miles (56.3 kms) in length, will be provided with gravel pavement of 10 feet width and utilized as the trunk roads of the Project Area supplementally to the service roads along the main canals and the national roads.

2) Bridges

Facilities crossing over the Pat Feeder Canal are only bridges with cross regulators and the national road bridge at RD 489. These existing bridges should be elongated depending on the extent of

Table IV. 4-8 List of Bridges

	Station	Particular	Existing Size	Proposed Expansion Case 1 (8,200 cusecs)	Proposed Expansion Case 2 (6,700 cusecs)
Desert Pat Feeder	RD 36	Railway B	40' x 8 = 320'	none	none
	36	Road B	320'	"	"
Par Feeder	RD 42	Village Road B	25' x 6 = 150'	25' x 3 = 75'	25' x 2 = 50'
	76	"	25' x 6 = 150'	25' x 3 = 75'	25' x 2 = 50'
	91	"	25' x 6 = 150'	25' x 3 = 75'	25' x 2 = 50'
	171	"	Proposed	32' x 7 = 224'	32' x 6 = 192'
	205	"	"	32' x 7 = 224'	32' x 6 = 192'
	280	"	"	32' x 7 = 224'	32' x 6 = 192'
	317	"	"	32' x 6 = 192'	32' x 5 = 160'
	365	"	"	32' x 6 = 192'	32' x 5 = 160'
	441	"	"	32' x 5 = 160'	32' x 4 = 128'
	489	Railway B	40' x 4 = 160'	none	none
		National Highway	24' x 5 = 120'	24' x 2 = 48'	24' x 1 = 24'
	530	Village Road B	Proposed	32' x 4 = 128'	32' x 3 = 96'
	585	"	"	32' x 3 = 96'	32' x 2 = 64'
Disty					
Lower Uch	RD 15.28	Village Road B	Proposed	24' x 2 = 48'	24' x 2 = 48'
	36.40	"	"	36' x 1 = 36'	30' x 1 = 30'
Nasirabad	37.00	"	"	20' x 1 = 20'	20' x 1 = 20'
	50.00	"	12' x 1 = 12'	18' x 1 = 18'	none
Jhuder	97.00	"	10' x 1 = 10'	none	"
Temple	23.99	"	Proposed	24' x 2 = 48'	24' x 2 = 48'
Jhatpat	76.60	"	10' x 2 = 20'	none	none
Ballan	87.00	"	12' x 1 = 12'	18' x 1 = 18'	"

Table IV.4 -9 List of Bridges over Plain Falls

Name of Distry	Station	Bridge Length cusecs Case 1 (8,200)	cusecs Case 2 (6,700)	Remarks
1. Bitti	RD 46.72	6' x 1 = 6'	6' x 1 = 6'	Proposed
	50.50	6' x 1 = 6'	6' x 1 = 6'	Proposed
	53.50	6' x 1 = 6'	6' x 1 = 6'	Proposed
2. Khallan	RD 40.20	6' x 1 = 6'	6' x 1 = 6'	Proposed
3. Lower Uch	RD 2.00	8' x 3 = 24'	8' x 3 = 24'	Proposed
	4.00	8' x 3 = 24'	8' x 3 = 24'	Proposed
	8.00	8' x 3 = 24'	8' x 3 = 24'	Already done
4. Nasirbad	RD 7.60	10' x 2 = 20'	10' x 2 = 20'	Proposed
	10.90	6' x 3 = 18'	6' x 3 = 18'	Proposed
	16.00	8' x 2 = 16'	8' x 2 = 16'	Already done
	22.00	14' x 1 = 14'	14' x 1 = 14'	Already done
	30.40	10' x 1 = 10'	10' x 1 = 10'	Already done
5. Jhudher	RD 29.37	6' x 4 = 24'	6' x 3 = 18'	Proposed
	34.40	12' x 2 = 24'	12' x 2 = 24'	Proposed
	52.93	10' x 2 = 20'	10' x 2 = 20'	Proposed
	60.91	10' x 2 = 20'	10' x 2 = 20'	Proposed
	69.93	8' x 2 = 16'	8' x 2 = 16'	Already done
	78.67	16' x 1 = 16'	16' x 1 = 16'	Proposed
	89.66	14' x 1 = 14'	14' x 1 = 14'	Proposed
6. Temple	RD 33.52	10' x 2 = 20'	10' x 2 = 20'	Proposed
	45.50	8' x 2 = 16'	8' x 2 = 16'	Already done
	67.74	10' x 1 = 10'	10' x 1 = 10'	Proposed
	76.17	8' x 1 = 8'	8' x 1 = 8'	Proposed

to be continued

Name of Distry	Station	Bridge Length cusecs Case 1 (8,200)	cusecs Case 2 (6,700)	Remarks
7. Jhatpat	RD 9.90	20' x 2 = 40'	20' x 2 = 40'	Proposed
	27.10	12' x 2 = 24'	12' x 2 = 24'	Already done
	40.00	28' x 1 = 28'	28' x 1 = 28'	Proposed
	51.84	6' x 3 = 18'	6' x 3 = 18'	Porposed
	61.50	8' x 2 = 16'	8' x 2 = 16'	Already done
	69.90	15' x 1 = 15'	15' x 1 = 15'	Proposed
8. Mohabatpur	RD 3.90	28' x 1 = 28'	28' x 1 = 28'	Proposed
	19.30	12' x 2 = 24'	12' x 2 = 24'	Proposed
	30.90	22' x 1 = 22'	22' x 1 = 22'	Proposed
	43.60	8' x 2 = 16'	8' x 2 = 16'	Already done
	54.50	14' x 1 = 14'	14' x 1 = 14'	Proposed
	67.00	10' x 1 = 10'	10' x 1 = 10'	Already done
9. Bari	RD 40.00	28' x 1 = 28'	28' x 1 = 28'	Proposed
	59.00	22' x 1 = 22'	22' x 1 = 22'	Proposed
	70.00	6' x 3 = 18'	6' x 3 = 18'	Already done
	80.00	18' x 1 = 18'	18' x 1 = 18'	Proposed
	90.00	18' x 1 = 18'	18' x 1 = 18'	Proposed
	105.00	14' x 1 = 14'	14' x 1 = 14'	Proposed
10. Ballan	RD 11.00	28' x 1 = 28'	28' x 1 = 28'	Proposed
	24.00	10' x 2 = 20'	10' x 2 = 20'	Already done
	37.00	22' x 1 = 22'	22' x 1 = 22'	Proposed
	49.00	6' x 3 = 18'	6' x 3 = 18'	Already done
	57.00	18' x 1 = 18'	18' x 1 = 18'	Proposed
	66.50	12' x 1 = 12'	12' x 1 = 12'	Proposed
	80.20	6' x 1 = 6'	6' x 1 = 6'	Proposed

to be continued

Name of Distry	Station	Bridge Length Case 1 (8,200 cusecs)	Case 2 (6,700 cusecs)	Remarks
11. Umrani	RD 9.68	8' x 4 = 32'	8' x 4 = 32'	Already done
	31.47	6' x 3 = 18'	6' x 3 = 18'	Proposed
	45.17	8' x 2 = 16'	8' x 2 = 16'	Already done
	59.00	6' x 2 = 12'	6' x 2 = 12'	Already done
	69.26	8' x 1 = 8'	8' x 1 = 8'	Already done
	79.36	5' x 1 = 5'	5' x 1 = 5'	Proposed
12. Rupa	RD 9.40	10' x 2 = 20'	10' x 2 = 20'	Already done
	17.30	8' x 2 = 16'	8' x 2 = 16'	Already done
	27.00	6' x 2 = 12'	6' x 2 = 12'	Already done
	41.80	6' x 1 = 6'	6' x 1 = 6'	Proposed
		2 12	2 12	
13. Mangsi	RD 40.00	6' x 2 = 12'	6' x 2 = 12'	Already done
	50.00	5' x 1 = 5'	5' x 1 = 5'	~~Already done~~ Proposed
		2 10	2 10	
14. Qabula	RD 19.02	6' x 5 = 30'	6' x 4 = 24'	Proposed
	28.02	6' x 4 = 24'	6' x 4 = 24'	Proposed
	38.02	6' x 4 = 24'	6' x 3 = 18'	Proposed
	49.02	6' x 3 = 18'	6' x 3 = 18'	Proposed
	59.02	6' x 3 = 18'	6' x 3 = 18'	Proposed
	71.02	6' x 2 = 12'	5' x 2 = 12'	Proposed
	86.02	6' x 1 = 6'	6' x 1 = 6'	Proposed
15. Murad	RD 20.02	6' x 6 = 36'	6' x 5 = 30'	Proposed
	40.02	6' x 6 = 36'	6' x 5 = 30'	Proposed
	60.02	6' x 5 = 30'	6' x 4 = 24'	Proposed
	80.02	6' x 4 = 24'	6' x 4 = 24'	Proposed
	100.02	6' x 3 = 18'	6' x 3 = 18'	Proposed
	115.02	6' x 3 = 18'	6' x 3 = 18'	Proposed
	127.52	6' x 2 = 12'	6' x 2 = 12'	Proposed

widening canals. Aside from the above modification, the construction of eight new bridges across the Pat Feeder Canal is proposed as tabulated hereinafter.

The national road bridge located at RD 489 of the Pat Feeder Canal should be elongated by 48 feet (14.60 m) with two spans in Case-1 and 24 feet (7.30 m) with one span in Case-2, while Pakistan Railways Bridge located together with the above national road bridge has a sufficient length of 166 ft (50.60 m) in widening the Pat Feeder Canal so that no modification will be required. However, rivetment works with brick lining for the protection of abutments of the railway bridge is proposed for about 120 feet (36.6 m) in length.

It is proposed to construct bridges across distributaries at 31 existing plain falls and also at all new plain falls proposed for Qabula and Murad distributaries in addition to the three across the distributaries proposed in PC-1.

The existing village road bridges over distributaries should be reconstructed due to the widening of canals. For the new village road bridges to be constructed over the Pat Feeder Canal, the reinforced concrete T-beam bridges of 32 ft span with brick-made abutments and piers are proposed from the economic and engineering view points.

A village road bridge proposed at the site of each regulator is designed to be the reinforced concrete slab one with 8 to 10 feet span which is the same as the existing one.

IV.4.8. On-farm Facilities

The proposed on-farm facilities are the main, internal and link water courses, farm drains and small structures such as nakka, division boxes, etc. All water courses will be constructed of earth.

To give the shape to the concept of the proposed on-farm facilities, the model design of irrigation and drainage canals as well as land parcelling were actually carried out for one sample area. Furthermore, the required costs for on-farm development were estimated for this sample area, and the results were applied to the design of on-farm development works in the whole Project Area. The construction and the operation and maintenance of on-farm facilities will have to be undertaken by the land owners basing on this model.

a) Determination of Sample Area

The sample area is located at the most northern area between Jhatpat-Muhbat Pur disttributary and Bollan distributary. Being at the central part of the Project Area, the sample area has natural conditions inclusive of topography prevailing in the Project Area. An acreage of the sample area is 17,490 acres (7,078 has) in gross area.

b) Land Parcelling and Preliminary Design

The land parcelling in the sample area was carried out on the contour map with a scale of four inches to one mile (1:15,800) given by the Jhatpat Division of Irrigation and Power Department, Baluchistan Government. As a result, one rotational area is determined at 80 acres (32.38 has) on an average.

The typical layout of on-farm facilities and the design of related facilities are shown in Drawing No.019 to No. 021.

The results of layout and design in shown below:

Results of Typical Design in Sample Area

Description	Total	Average
1. Area		
Gross Area	17,490.3 ac (7,078.3 ha)	
Culturable Commanded Area	15,562 ac (6,297.9 ha)	
Number of Chak	45 No (45 No)	
Area of Chak		398 ac (157.4 ha)
Number of Rotational Area	189 No (189 No)	
Area of Rotation Area		82.3 ac (33.3 ac)
Description	**Total**	**Average**
2. Major Facilities		
Main Water Course	275,000 ft (83,820 m)	17.7 ft/ac (13.3 m/ha)
Internal Water Course	431,500 ft (131,520 m)	27.7 ft/ac (20.9 m/ha)
Link Water Course	467,000 ft (142,340 m)	30.0 ft/ac (22.6 m/ha)
Nakka	189 No (189 m)	- (-)
Division Box	945 No 945 m)	- (-)
Farm Drain	313,400 ft (95,520 m)	20.1 ft/ac (15.1 m/ha)
Branch Drain	329,900 ft (97,500 m)	20.6 ft/ac (15.5 m/ha)
Division Box	945 No	

See Appendix IV 4-6 for the details of preliminary design.

IV.5. Pilot Project

IV.5.1. Objectives of Pilot Project

Agricultural development is a complex business. A great deal of money, effort and time have been wasted by seizing on something or other single problem as panacea for all the ills of agriculture. A harmonious combination of all inter-related factors such as experiments, research, extension, production, credit, storage and marketing with full support from public as well as the private sector is a must for speedy development of the agriculture.

The link between the experiments or research and productive practice of farmers is not so tight. Results of study or research are very hard to apply in the field by farmers themselves. Experiments and research, off course, should be continued by respective experts of the field concerned for further development of science. For linkage of the above two, researchers and farmers, there is a need for Trial Farm (Applied Research) which should be brought as close to the farmers field as possible. Experiments in the Applied Research such as selection test of crops to be introduced into the Project Area, comparative yield with several application of irrigation, fertilizer trial and chemical spray, practice of new techniques of culture and so on, should be carried out on the Trial Farm (Applied Research).

Based on the results of the Trial Farm, applicable farming method is practised in the Demonstration Farm before extending every farming technique and knowledge to the Central Extension Farm of the Pilot Project. In the Demonstration Farm, most recommendable farming for the farmers in the Project would be practiced and also it will be utilized as text material for trainees attending at the training course at the Pilot Project.

Besides the Demonstration Farm, the Central Extension Farm is provided in the Pilot Project. The Central Extention Farm is centered on Extension Farms to be established entirely in the Project Area. Through various achievement of the Demonstration Farm, practices on every developed agricultural technique and proper water management with a complete provision of irrigation and farming facilities are exercised.

For sufficient supply of recommendable seeds to be used in the Central Extension Farm and Extension Farms, Seed Multiplication Farm is also established in the Pilot Project.

Since the farmers are quite conservative to introduce new idea or inexperienced matter to their farming, aside from the Demonstration Farm, the Central Extension Farm in showing every new practice tried in the Demonstration Farm through research in the Trial Farm and concluded even tentatively to introduce it to the area, would perform significant role to diffuse the such to formers in the Area.

To extend valuable information on modernized agriculture and to transfer such knowledge of technology to farmers in the Project Area effectively, training programme should be conducted as one of functions of the Pilot Project.

Through the function of the Pilot Project, the agricultural development in the Pat Feeder Canal Project Area will be materialized quickly and farmers living in the Area will be beneficial much. The scheme of the Pilot Project is an impact for the agricultural development in the Area and also as far as farmers concerned it gives them encourages in a sense of "Seeing is Believing".

The implementation of the Pilot Project should be commenced prior to the implementation of the Agricultural Development Project with Widening of Pat Feeder Canal in consideration of its important role to demonstrate various matters to be beneficial farmers and on provision of many facilities and buildings for the purpose.

IV.5.2. Proposed Agricultural Development

The Pilot Project includes the following plans for agricultural supporting services to secure successful farm production in "After the Project" with widening of Pat Feeder Canal.

a) A Trial Farm (applied research farm) will be provided in the Pilot Project, and various applied researches will be conducted under proper water management by selecting suitable varieties of crops.

b) The modern mechanized farming will be demonstrated, and the extension services will be rendered for mechanized farming techniques.

c) Modern irrigation facilities will be constructed in the Pilot Project, and a study on design criteria for such facilities for the future reference and practice on operation and maintenance of the facilities will be carried out.

d) Intensified extension services and training of farmers will be given for the improved techniques of irrigated agriculture.

Various schemes of the agricultural development in the Pilot Project are described in the following:

1) Proposed Land Use

For the establishment of the Pilot Project, a gross area of 3,650 acres (1,477 has) is selected, and the following land use programme is proposed;

1. Engineering Quarters	12 acres
2. Farm Pond & Pump Station for Irrigation Facilities	7
3. Roads, Irrigation & Drainage Canals and Others	631
Sub-total (1 to 3)	650 acres (263 has)

4.	Demonstration of Irrigation Facilities	85
5.	Trial Farm	160
6.	Demonstration Farm	320
7.	Central Extension Farm	1,965
	Sub-total (4 to 8)	3,000 acres
		(1,214 has)
	Total (Gross Area)	3,650 acres
		(1,477 has)

To operate effectively the Pilot Project, the proposed land for the above-mentioned items 1 to 5, 895 acres in total, including the existing roads, canals and miscellaneous lands, should be acquired by the Project while land ownership of land for the other purpose is not transferred.

2) Demonstration of Irrigation Facilities

Irrigation is a necessity for agricultural production, especially for the cultivation of vegetables and fruits. Production of vegetables and fruits is a necessity for improvement or leveling up of living standard. When the agricultural development in the Project is implemented and the living standard of farmers is dramatically improved due to expected farmers income, needs for more production of the vegetables and fruits will be prospected. Although surface gravity irrigation method can be used for irrigation in the production of vegetables and fruits, however, for the such production in the future modernized irrigation method will be required. Before such time comes, it is obvious that experience and practice on design of the said modernized irrigation method and operation of the facilities will be much contributed to the engineering and also rural developments.

In this connection, the use of modernized irrigation facilities such as fixed and portable sprinklers, raingans and trickles are

proposed in the demonstration of irrigation facilities in the Pilot Project.

In the demonstration of irrigation facilities, a study on design criteria on these facilities will be made, and the practice of proper water management will also be carried out.

3) Trial Farm (Applied Research Farm)

Since there are no available research data and actual growing experience of farmers in the Project Area as regards irrigated agriculture with proper water management and complete provision of irrigation facilities, particularly on-farm facilities, it is recommended to set up the Trial Farm (Applied Research Farm) to be used in the proposed multiple cropping scheme.

The specific objectives of the applied research project are as follows:

a) Adaptability test (variety applied research) is carried out to determine the adaptability of crops.

b) Planting method trial test is provided to determine the planting method of the crops in agronomical and economic aspects which include the irrigation application test, too.

c) Fertilizer and chemicals application test is tried to determine such application timing and amount.

The design of the Trial Farm is preferably simplified. The normal replication procedure is done away with. Individual experimental site of one-fifteenth to one-twentieth of one acre lot will be considered as one replication and thus serve as an effective extension total in the area.

4) Demonstration Farm

Generally speaking, farmers are very conservative to introduce new idea/techniques in their farming, because they know that environmental conditions will differ year by year so as to avoid any risk by continuing a traditional farming which has been experienced by farmers themselves for a long time without much risks.

To develop and improve agricultural productivities, modernized farming techniques, new varieties of crops and new input and application of agri-chemicals should be introduced, otherwise, the agricultural development can not be realized.

To introduce such modern farming techniques and other to the farmers through the establishment of demonstration farm would be significant important in hastening agricultural development.

5) Central Extension Farm

Through the experiments in the Trial Farm and Demonstration Farm, the modernized farming with new varieties and other recommendable materials under proper water management practice would be implemented in the Centeral Extension Farm as a show-window to the farmers and Extension Farms to be established entirely in the Project Area.

The Central Extension Farm to be fully equipped with irrigation facilities would function and be operated under the sufficient agricultural supporting services. 6) Seed Multiplication Farm

Seed is the physical basis of agricultural production because all the other agricultural inputs react with the seed in the soil on the crop production. No other input can substitute or compensate for the inferior quality of germ plasm contained in the seed. For obtaining a higher agricultural production, the supply of superior

quality pedigree seed is a prerequisite. There is a need to have a sound multiplication and certification programme to ensure the availability of quality seed for the Extension Farms in the Project Area as well as the Central Extension Farm.

7) Training Programme

In the engineering quarters of the Pilot Project aside from office building, a training center with adequate educational facilities and a rest house will be provided for training programme.

To difuse effectively valuable information on modernized agriculture and to transfer such knowledge of technology to farmers in the Project Area, training programme should be conducted as one of the functions of the Pilot Project. The training programme will be composed of three major trainees, i.e., (i) for officials of government and governmental agencies in charge of agricultural development, (ii) for village leaders and promotors in the village level expected as pioneers in the activities on the diffusion of the objective matters and (iii) for farmers to learn new techniques and others.

IV.5.3. Proposed Facilities

The facilities required are proposed below:

1) Engineering Quarters

Engineering quarters are composed of the following buildings and facilities for administration/management of the Pilot Project, laboratory, warehouse, training and lodging:

Office	100 x 45 ft 4,500 sq.ft	Manager, Administration, Cashier, and Staff Rooms
Researcher's Office	100 x 65 ft	Sample Preparation Room,

Laboratory	6,500 sq.ft	Laboratory Room, Research Rooms and Storage
Training Center	75 x 30 ft 2,250 sq.ft	Lecture Rooms, Library, Show Room and Storage
Rest House	40 x 95 ft 3,800 sq.ft	Dormitory for Trainees
Garage	25 x 65 ft 1,625 sq.ft	Garage for Vehicles and Spare Parts Storage
Warehouse	75 x 40 ft 3,000 sq.ft	Agro-chemical and Fertilizer
Warehouse & Workshop	160 x 50 ft 8,000 sq.ft	Garage for Agro-Machine and Workshop
Warehouse & Seed Processing Plant	180 x 65 ft 11,700 sq.ft.	Seed Storage and Seed Processing
Staff Quarters	50 x 30 ft x 12 30 x 40 ft x 19 40,800 sq.ft	Lodging for Staff

Besides, a fuel station, a parking space and water purification facilities for the engineering quarter are provided. The capacity of the water purification facilities for the engineering quarter will be 1,760 cu.ft (50 cu.m)

2) Agricultural Machinery

The following agricultural machinery are provided for the operation of the Pilot Project, and also utilized for the training purpose.

Machinery	Capacity		Unit
Tractor	Four Wheel	60 PS	12 Units
Dump Trailer		2 Ton	12
Power Tiller		8 - 9 PS	14
Power Sprayer		5 PS	5
Nap Sac Type Sprayer		3.8 PS	17
Transplanter	Auto 8 lines	9.5 PS	5
Transplanter	4 lines	3.5 PS	7
Seed Drill		4.5 PS	5
Seedling Plant			1
Binder	While Type 2 lines		12
Harvester		7 PS	12
Combine	4 lines harvest	22 PS	5
Weed Cutter		1.5 PS	29
Grain Dryer	Capacity 2 ton/hr		5
	0.5 - 0.7%		

3) Training Instrument and Equipment

The following instruments and equipment are provided for the training.

Audio-Visual Educational Facilities	1 set
Transportation	
Utility Jeep	5 units
Truck	3 units
Micro-Bus	1 units

4) Demonstration of Irrigation Facilities

At the head of minor canals of the Pilot Project diverging from the Jhatpat Distributary, the provision of the demonstration of irrigation facilities covering a cultivable commanded area of 85 acres, farm pond and related facilities are proposed. The major dimensions of the facilities are as follows:

a) Farm Pond

Bed Width and Length		138 ft (42 m)
Depth	Design Depth	7 ft (2.10 m)
	Freeboard	2 ft (0.60 m)
	Total Depth	9 ft (2.70 m)
	Effective Capacity	145,000 cu.ft (4,200 m^3)

Rivetment Brick Lining with a Slope of 1:1

b) Pump Station

(i) Sprinkler Irrigation (Fixed and Portable) and Raingun

Single Suction Volute Pump (FS4L Type) 3 units

Pump Bore	6 inch x 5 inch (150 x 125 mm)
Total Dynamic Head	141 ft (43 m)
Discharge	1.53 cusec (2.6 m^3/min)
Number of Rotations	1,460 RPM
Motor	37 kw

Pressure Tank for 3 units of pumps, 7 m^3 1 set

Sluice Valve 6 inch (150 mm) 3 units

Main Pipe Lines 10 inch (250 mm) 2 units

(ii) Trickle Irrigation

Single Suction Volute Pump (FS 4K Type) 2 units

Pump Bore	3 5/8 inch x 2 1/2 inch (80 x 65 mm)
Total Dynamic Head	150 ft (32)
Discharge	0.67 cusec (1.13 m^3/min)
Number of Rotations	1,450 PPM
Motor	11 KW

Pressure Tank for 2 units of pumps, 3 m^3 1 set

Sluice Valve 4 inch (100 mm) 2 units

6 inch (150 mm) 1 unit

c) Main Pipe Lines

(i) For Sprinkler (Fixed and Portable) and Raingun

Pump Station to Diversion Point	12" (300 mm) ϕ	Length	50 ft
Diversion Point to Sprinkler (Fixed)	8" (200 mm) ϕ	Length	1,070 ft
- do -	6" (150 mm) ϕ	Length	320 ft
- do -	4" (100 mm) ϕ	Length	260 ft
Diversion Point to Sprinkler (Portable)	12" (300 mm) ϕ	Length	540 ft
	8" (200 mm) ϕ	Length	840 ft
	6" (150 mm) ϕ	Length	400 ft
	5" (125 mm) ϕ	Length	120 ft
Diversion Point to Raingun	10" (250 mm) ϕ	Length	920 ft
	8" (200 mm) ϕ	Length	525 ft
	6" (150 mm) ϕ	Length	420 ft

(ii) For Trickle

Pump Station to Trickle	8" (200 mm) ϕ	Length	1,735 ft
	6" (150 mm) ϕ	Length	1,400 ft
	5" (125 mm) ϕ	Length	720 ft
	4" (100 mm) ϕ	Length	720 ft
	3" (75 mm) ϕ	Length	270 ft

d) Sprinkler Irrigation (Fixed)

Cultivable Commanded Area			20 acres
Pipeline	1 1/2"	(40 mm) ϕ	9,750 ft
	2"	(50 mm) ϕ	2,900 ft
Sprinkler	(3/16" x 3/32")		350 sets

e) Sprinkler Irrigation (Portable)

Cultivable Commanded Area			25 acres
Portable Pipe	1/12"	(40 mm) ϕ	1,056 ft
	2"	(50 mm) ϕ	1,320 ft
Portable Sprinkler	(1/4" x 1/8")		40 sets

f) Raingun Irrigation

Cultivable Commanded Area			20 acres
Pipelines	2 5/8"	(65 mm) ϕ	1,770 ft
	3 "	(75 mm) ϕ	3,540 ft
	4"	(100 mm) ϕ	2,655 ft
Raingun	(1/2")		75 sets

g) Trickle Irrigation

Cultivable Commanded Area	20 acres
Tube	306,000 ft
Emitter	102,600 sets

5) On-Farm Facilities

On-farm facilities in the Pilot Project should completely be provided. The proposed major facilities are as follows:

a) Road

Offtake (Constant Head Orifice Turnout)		1 unit
Minor Canal	Length	29,000 ft
Outlet		11 units
Main Water Course		33,000 ft
Nakka		41 units
Internal Water Course		100,000 ft
Division Box		202 units
Link Water Course		234,000 ft

b) Drainage Canal

Farm Drain	81,000 ft
Branch Drain	100,000 ft

6) Check Structure

The installation of a rubber dam at RD 9.9 of Jhatpat Distributary is proposed as a check structure to control the water level of the canal upstream of the check structure free of the fluctuation of discharge.

IV.6. Project Cost

The total investment cost including the price escalation during the implementation period is estimated at Rupees 2,165 million (US$ 196.81 million) for Case-1 and Case-3, at about Rupees 1,892 million (US$ 172 million) for Case-2 and Case-4.

Table IV.6-1 shows a summary of the investment cost of the Project.

The economic project cost of the proposed development scheme (Case-3) is estimated at Rupees 2,470(US$ 225) per acre or Rupees 6,096 (US$ 554) per hectare based on the following conditions; i) depreciation cost of the construction equipment is involved in the unit cost of the civil works instead of the cost of the construction equipment and ii) price escalation is not included.

The annual disbursement schedule for the investment cost is shown in Tables IV.6-2 and IV.6-3 of Appendix IV 6-2. The cost estimates of the Project were made in the following manner:

1) Civil Works

The cost of the civil works consists of the construction cost of engineering works for the Project, which are estimated based on the respective unit costs of construction materials, fuel and oil, repair of equipment and labour. The depreciation costs of the construction equipment and workshop equipment to be imported are not included in the items of the civil works. The civil works consist of the following items:

Desert Pat Feeder Canal:

to include earth works for the Desert Pat Feeder Canal and related structures.

Pat Feeder Canal:

to include the earth works for the Pat Feeder Canal and related structures

Distributaries:

to include the earth works for the distributaries and related structures

Minor Canals:

to include construction of minor canals and the rehabilitation of parts of main water courses to be changed as minor canals and related structures such as outlets.

Roads:

to include construction of metalled pavement of main canal service roads and gravel pavement of distributary service roads.

Pre-Engineering:

to include the survey works for major works such as Desert Pat Feeder Canal, Pat Feeder Canal, distributaries and minor canals, and hydrological observation and agricultural survey.

2) Land Acquisition and Compensation

Land acquisition and compensation cost for irrigation facilities and project facilities are estimated.

3) Construction Equipment

The construction equipment and spare parts will be purchased under the Project in the lump except small equipment which are able to be easily provided by the contractor.

The cost of construction equipment and spare parts is estimated on the basis of CIF Karachi, exclusive of the custom duties and other local taxes to be imposed in Pakistan. Unloading cost at Karachi Port and inland transportation cost from the port to the construction site are added to the above purchase cost.

4) Agricultural Development

The costs required for agricultural supporting services include the cost for cadastral survey.

5) Operation and maintenance

The project cost involves the operation and maintenance cost for three years each for the Stage-I Implementation from the middle of 1988 to the middle of 1991 and for the Stage-II Implementation from the middle of 1989 to the middle of 1992 in which the operation and maintenance of the Project facilities having been already constructed are required.

6) Project Facilities and Administration

The cost required for the construction and purchasing of the Project facilities such as office buildings, field office buildings, furnitures and equipment and the administrative charge of government staff to be engaged in the newly organized project office are estimated at eight per cent of the total cost.

7) Consulting Services

The engineering cost for consultants of foreign and local experts for the implementation of final design and supervision of the Project are included.

8) Contingency

Allocation to contingency is included in the total base to cover minor differences in actual and estimated quantities, unforeseeable difficulties in construction, possible change in plan because of site conditions or uncertainties in foundation conditions.

The adopted percentage of contingencies on each item for the Project is 15 per cent, except the items for construction equipment to which 10 per cent is applied.

9) Price Escalation

The price escalation rates of seven per cent and nine per cent are adopted for foreign currency and local currency, respectively.

10) Unit Cost

The cost of construction materials and labour to be used in the Project is estimated on the basis of the prevailing prices as of March, 1982 in Pakistan.

The cost of materials and equipment to be imported is estimated on the basis of CIF Karachi.

The exchange rates applied are 11.00 Rupees or 230 Japanese Yen against one U.S. Dollar.

11) Foreign and Local Components of the Cost

The cost for such materials as cement, steel bars, fuel and oil, etc. are divided into two portions of foreign and local components as shown below:

Item	Foreign Component (%)	Local Component (%)
Cement	70	30
Steel Bar	53	47
Fuel and Oil	84	16

12) Conversion Factor

The following conversion factor is applied for economic cost estimate of the Project.

Standard Conversion Factor	0.86
Conversion Factor of Consumption	0.90

13) Interest

Interest on capital investment during the construction is estimated at annual rates of 3 percent and 8 percent of the annual phasing expenditures, taking into consideration the annual rates applied internationally.

TABLE IV. 6-1 INVESTMENT COST OF THE PROJECT

(Unit : Rs.'000)

Description	Case-1 and Case-3			Case-2 and Case-4		
	Total	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency
A. Pilot Project						
1. Contruction of Facilities	53,213	10,945	42,268	53,213	10,945	42,268
2. Land Acquisition & Compensation	1,700	-	1,700	1,700	-	1,700
3. Agricultural Development	19,936	8,786	11,150	19,936	8,786	11,150
4. Consulting Services	10,450	8,470	1,980	10,450	8,470	1,980
Sub-total (1 to 4)	85,299	28,201	57,098	85,299	28,201	57,098
5. Contingency	12,701	3,799	8,902	12,701	3,799	8,902
Sub-total (1 to 5)	98,000	32,000	66,000	98,000	32,000	66,000
6. Price Escalation	15,000	3,000	12,000	15,000	3,000	12,000
Total	113,000	35,000	78,000	113,000	35,000	78,000
B. Stage-I Implementation						
1. Civil Works						
Desert Pat Feeder Canal	57,337	34,788	22,549	45,389	27,883	17,506
Pat Feeder Canal	206,823	76,721	130,102	159,529	56,105	103,424
Distributaries	6,752	2,935	3,817	3,855	1,915	1,940
Minor Canals	9,694	5,097	4,597	8,803	4,593	4,210
Road	22,631	5,895	16,736	22,631	5,895	16,736
Pre-Engineering	5,000	-	5,000	5,000	-	5,000
2. Land Acquisition & Compensation	1,326	-	1,326	1,326	-	1,326
3. Construction Equipment	229,870	206,883	22,987	149,714	134,742	14,972
4. Agricultural Development	4,562	2,533	2,029	4,562	2,533	2,029
5. Operation & Maintenance	4,167	2,944	1,223	4,167	2,944	1,223
6. Project Facilities	6,308	750	5,558	6,308	750	5,558
7. Project Administration	17,873	-	17,873	13,683	-	13,683
8. Consulting Services	44,880	37,400	7,480	44,880	37,400	7,480
Sub-total (1 to 8)	617,223	375,946	241,277	469,847	274,760	195,087
9. Contingency	79,777	45,054	34,723	63,153	34,240	28,913
Sub-total (1 to 9)	697,000	421,000	276,000	533,000	309,000	224,000
10. Price Escalation	237,000	115,000	122,000	187,000	86,000	101,000
Total	934,000	536,000	398,000	720,000	395,000	325,000
C. Stage-II Implementation						
1. Civil Works						
Desert Pat Feeder Canal	-	-	-	-	-	-
Pat Feeder Canal	146,301	77,536	68,765	131,754	69,723	62,031
Distributaries	105,193	55,064	50,129	98,780	52,815	45,965
Minor Canals	78,189	41,115	37,074	71,001	37,049	33,952
Road	125,076	16,439	108,637	125,076	16,439	108,637
Pre-Engineering	12,000	-	12,000	12,000	-	12,000
2. Land Acquisition & Compensation	10,884	-	10,884	10,884	-	10,884
3. Construction Equipment	-	-	-	-	-	-
4. Agricultural Development	16,418	-	16,418	16,418	-	16,418
5. Operation & Maintenance	9,892	-	9,892	9,892	-	9,892
6. Project Facilities	29,404	-	29,404	29,404	-	29,404
7. Project Administration	27,783	-	27,783	24,055	-	24,055
8. Consulting Services	23,870	19,800	4,070	23,870	19,800	4,070
Sub-total (1 to 8)	585,010	209,954	375,056	553,134	195,826	357,308
9. Contingency	86,990	31,046	55,944	82,866	29,174	53,692
Sub-total (1 to 9)	672,000	241,000	431,000	636,000	225,000	411,000
10. Price Escalation	446,000	135,000	311,000	423,000	126,000	297,000
Total	1,118,000	376,000	742,000	1,059,000	351,000	708,000
Grand Total (A + B + C)	2,165,000	947,000	1,218,000	1,892,000	781,000	1,111,000
Implementation Cost	1,287,532	614,101	673,431	1,108,280	498,787	609,493
Contingency	179,468	79,899	99,569	158,720	67,213	91,507
Price Escalation	698,000	253,000	445,000	625,000	215,000	410,000

TABLE IV.6-2 INVESTMENT COST OF THE PROJECT
INCLUDING INTEREST DURING CONSTRUCTION

(Unit: Million Rs.)

Description	Case-3	Case-4	Staged Development Plan
A. Pilot Project			
1. Local Costs	57.098	57.098	-
2. Foreign Exchange Costs	28.201	28.201	-
Sub-total	85.299	85.299	-
3. Contingency	12.701	12.701	-
Sub-total (1 to 3)	98.000	98.000	-
4. Interest at 8%	10.000	10.000	-
Total (1 to 4)	108.000	108.000	-
5. Price Escalation	15.000	15.000	-
Total (excluding 4)	113.000	113.000	-
B. Stage-I Implementation			
1. Local Costs	241.277	195.087	172.399
2. Foreign Exchange Costs	375.946	274.760	266.332
Sub-total	617.223	469.847	438.731
3. Contingency	79.777	63.153	57.969
Sub-total (1 to 3)	697.000	533.000	496.700
4. Interest at 8%	139.000	109.000	99.800
Total (1 to 4)	836.000	642.000	596.500
5. Price Escalation	237.000	187.000	169.300
Total (excluding 4)	934.000	720.000	666.000
C. Stage-II Implementation			
1. Local Costs	375.056	357.308	202.688
2. Foreign Exchange Costs	209.954	195.826	179.387
Sub-total	585.010	553.134	382.075
3. Contingency	86.990	82.866	57.025
Sub-total (1 to 3)	672.000	636.000	439.100
4. Interest at 8%	169.000	160.000	112.700
Total (1 to 4)	841.000	796.000	551.800
5. Price Escalation	446.000	423.000	283.900
Total (excluding 4)	1,118.000	1,059.000	723.000
Grand Total (A+B+C)			
1. Local Costs	673.431	609.493	375.087
2. Foreign Exchange Costs	614.101	498.787	445.719
3. Contingency	179.468	158.720	114.994
4. Interest at 8%	318.000	279.000	212.500
5. Price Escalation	698.000	625.000	453.200
Total of 1,2,3 and 4	1,785.000	1,546.000	1,148.300
Total of 1,2,3 and 5	2,165.000	1,892.000	1,389.000

Note: Investment Cost for Staged Development Plan is discussed in detail in Volume IV (Supplementary Study).

CHAPTER V. PROJECT IMPLEMENTATION AND OPERATION

CHAPTER V. PROJECT IMPLEMENTATION AND OPERATION

V.1. Executing Agency

The contract-basis implementation is recommended for the Project works involving voluminous excavation of those canals of the Desert-Pat Feeder, the Pat Feeder, distributaries and minor canals and the works should be under supervision of the Government agency concerned with assistance of consultants.

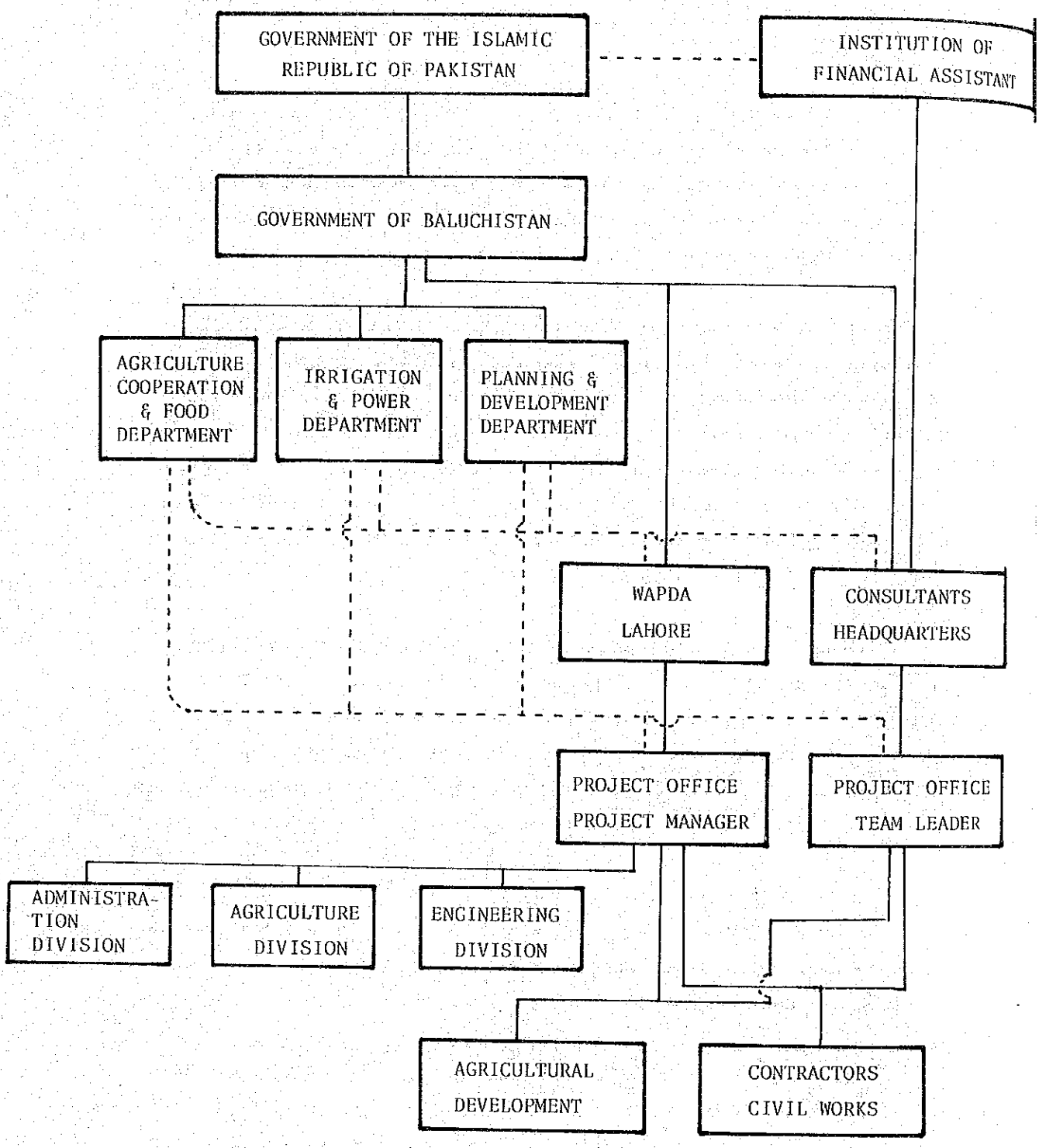
The Project Steering Committee will be organized by the representatives of various Governmental agencies concerned in order to smoothly implement the Project. The Committee will secure the closest coordination among the related departments and authorities concerned, and request them to extend their assistances and give advice directly or indirectly to the Project. The Committee will also show the administrative guidelines to the Project from time to time.

Although the Federal Government is in a position to assign a government agency as executing agency of the Project, the WAPDA is recommended as the one to meet the Project requirements. The WAPDA could be fully responsible for the Project implementation under supervision of the Irrigation and Power Department of Baluchistan and the Consultants. The organizational set-up is illustrated in Fig. V.1-1.

The Project Manager is fully responsible to execute the Project works in keeping a close coordination among the related departments and authorities concerned.

Under the control of the Project Manager, the divisions of administration, agriculture and engineering will be organized. In the organization, the engineering division would be responsible for

Fig. V. 1-1 PROPOSED ORGANIZATION FOR IMPLEMENTATION



the preparation of plans, programmes, designs and estimates of the facilities as well as construction supervision. The administrative division would be responsible for personnel affairs and record management, accounting, property, procurement and other services. The agricultural development scheme of the Project would be handled by the agriculture division.

The Project aims at an integrated agricultural development in the Project Area, so that a close inter-agencies coordination among the Irrigation and Power Department, the Planning and Development Department, the Agriculture Cooperation and Food Department and the other related agencies of the Baluchistan Government is an essential requirement.

V.2. Construction Method and Schedule

V.2.1. Construction Method

The widening of the Pat Feeder Canal has been planned to be undertaken on the contract basis after due consideration of the present construction systems in various fields in Pakistan.

The construction works of the main canal will be carried out in two shifts a day by dragline with four cubic yards (3.1 cu.m) and bulldozer with 32 tons. To withdraw sediments deposited in the canal, sand pumps and sand dredgers will be introduced. After the completion of the Project, the said sand pumps and sand dredgers would be utilized for the operation and maintenance of the canal system.

The construction of distributaries and minor canals will be made by backhoe with backet of 1.5 cubic yards (1.2 cu.m) in two shifts a day as well due to the magnitude of the canals. Hauling excavated

materials and embankment materials will be made by using 11-ton-class dump trucks 11-ton-class and 11-ton-class bulldozers will be considered.

As for the expansion and modification of the structures, a coffer dam to be constructed in the canal with sand bags and clayey materials is proposed, while the construction of a national road bridge will require to make an appropriate detour around the site.

V.2.2. Construction Schedule

The construction schedule is carefully studied taking into account the work volume and the Project cost. As a result, the construction period of three years each for Stage-1 and Stage-II, starting from September 1985 and September 1987 respectively, has been contemplated, and the detailed design, tendering and the Pilot project would be executed one after another so as to be completed before September 1985 as shown in Fig. V.2-1.

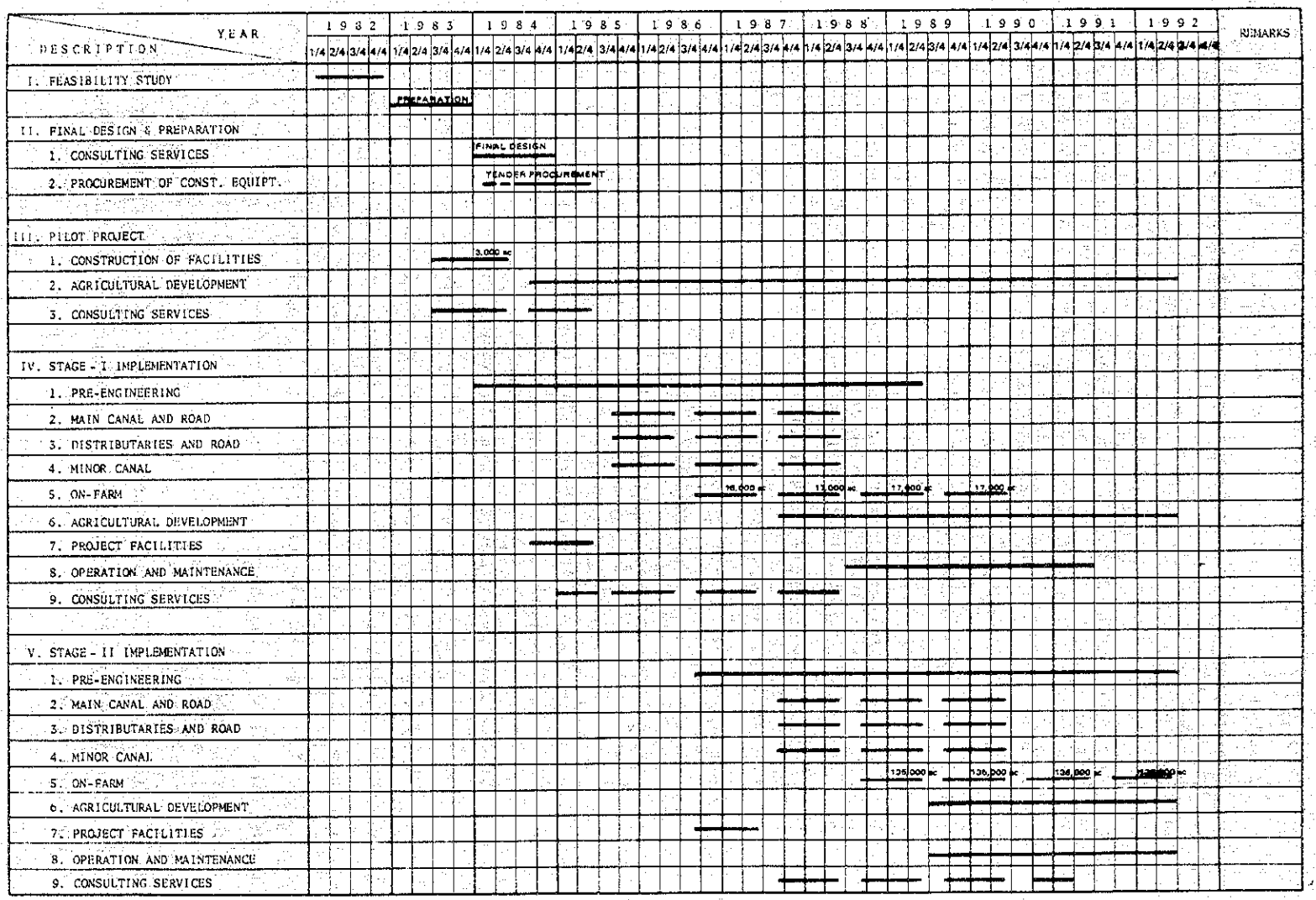
For the successful Project execution, a due consideration shall be paid to the following points:

a) The feasibility study on the Project will be completed by the end of 1982 so that the financial arrangements for the Project implementation can be made within 1983.

b) The final design for the Project, including construction survey and preparation of tender documents for the construction works will be finished in one year of 1984, and such pre-engineering works shall be made early in this period as preparatoration of tender documents, tendering and contracting of procurements of construction equipment and materials.

c) The construction of the Pilot Project shall be made within one year from mid 1983 to mid 1984 in advance to the full-scaled

FIG. V.2-1 IMPLEMENTATION SCHEDULE



project work, aiming at quick and effective diffusion of modern farming techniques of irrigated agriculture in the entire Project Area through the early provision of irrigation/drainage facilities, training facilities and agricultural supporting services.

d) The construction works are scheduled to be staged into two. The Stage-I construction is programmed to be commenced in the middle of 1985, and will take three years up to the middle of 1988 while the Stage-II construction in the middle of 1987, taking three years for completion in the middle of 1990..

e) On-farm development will be undertaken by farmers themselves under the engineering assistance of the Project. The said on-farm development is scheduled to be made in four years from one year after the completion of the related distributaries and minor canals.

V.3. Operation and Maintenance

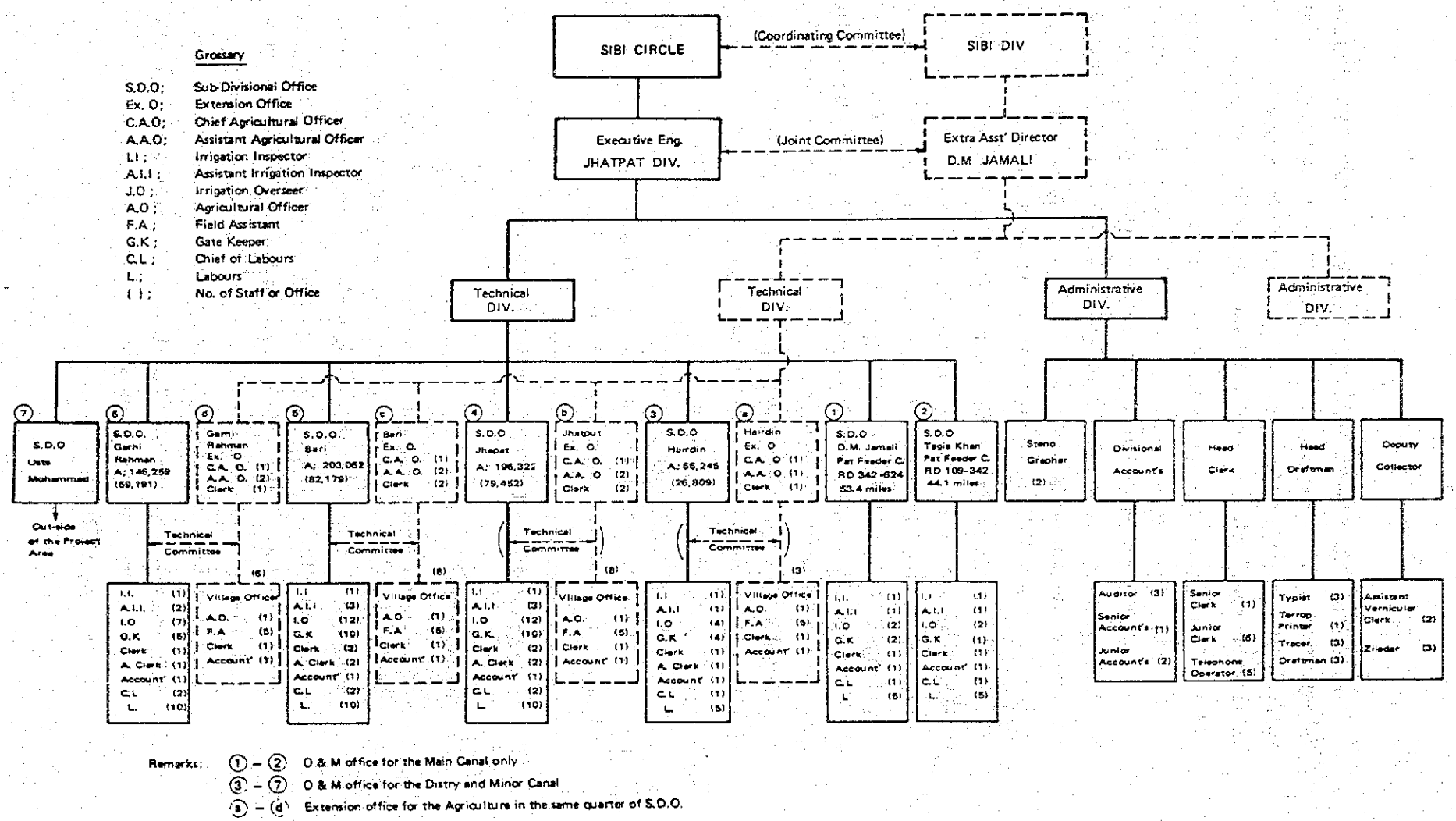
V.3.1. Executing Agency and Organization

1) Present Executing Agency and Organization

The Irrigation and Power Department of Baluchistan has assigned one chief engineer to control the existing irrigation projects, which have been divided into five irrigation circles in the Province. The irrigation circles are managed by one superintending engineer and a few executive engineers, and one executive engineer controls one irrigation system.

The Project Area, belong to the Sibi irrigation circle, is divided into five divisions of Kashmore, Temple, Thatpat, Hairdin and Usta Mohammad.

FIGURE V 3-1 PROPOSED ORGANIZATION CHART OF OPERATION AND MAINTENANCE OF THE PROJECT



Remarks: ① – ② O & M office for the Main Canal only
③ – ⑦ O & M office for the Distry and Minor Canal
⑤ – ⓓ Extension office for the Agriculture in the same quarter of S.D.O.

The division has an office stationed by one division chief. Sub-engineer, sub-divisional clerks, Abdar and Darogha assist and support him directly in the operation and maintenance of the irrigation facilities in the area (See Appendix Fig. V.3-1, V.3-2, and Table V.3-1).

In connection with the operation and maintenance of irrigation facilities, there are the boundaries between the provincial government and farmer's group in the Project Area, and the division office is responsible for maintaining the main canal and distribution canals, while the farmer's group is operating and maintaining water courses.

Regarding the supporting services for agriculture, especially, the extension services are carried out under the agriculture extension system of the province by a director who reports to the provincial secretary of agriculture, and the extra assistant director is controlling the services at the district level.

The investigation in the Project Area revealed that staffing is poor as well as transportation and housing facilities are quite inadequately provided.

2) Proposed Executing Agency and Organization

a) Organization

Basically the existing organization shall be respected and adapted to the Project Area as the proposed organization as shown in Figure V.3-1. According to the proposed irrigation plan, the main canal shall be further extended to cover an additional commandable area, and the expecting extension was estimated at 12.5 miles in length and an increased irrigable area at 146,260 acres. From this, it is proposed to establish an additional sub-divisional office and to reinforce staffing to the office additionally.

Furthermore, the minor canals have been proposed to be constructed under the control of the government. The total length of canals to be constructed was estimated at about 780 miles (1,255 km).

Concerning the proposed facilities for the irrigation plan, construction of six sub-divisional offices was proposed except Usta Mohammad sub-division office. The offices, No.1 and 2, are for the main canals, and the other offices are for the operation and maintenance of the distributaries and the minor canals.

In order to reinforce the existing organization of extension works, it has been proposed to assign one field assistant for 500 farmers or 5,000 acres, and one agricultural officer may supervise five field assistants, and this group is necessary to have one village office in their jurisdiction.

Furthermore, the extension offices are required as headquaters of village offices. The extension offices will be under the control of a sub-divisional office of the irrigation. Its office space should be prepared in the same quarter or building as that of the sub-divisional office.

The communication between the irrigation side and agricultural side is important for successful farm management with irrigation.

In this connection, it is proposed to establish both the technical and the joint committees. The participation of farmers' representatives to the both committees will be necessary.

V.3.2. Operation and Maintenance of Facilities

1) Present Condition

The field investigation found some problems and weak points in the operation and maintenance of the existing facilities as follows.

a) Intake, regulating and distribution facilities

There are illegal intake structures along the main canal, which have caused water distribution in inbalance both in the upstream and downstream of the Project Area.

There are no distribution facilities with discharge control function the heads of water course. Usually, diameters of distribution pipes are determined based on the acreage of commandable areas, although it is difficult to practically measure the discharge.

b) Sediment

Sedimentation affects the main canal (Pat Feeder Canal) and distribution canals. Especially, the upstream of the main canal is seriously affected by heavy sediments accumulated on the canal bed, and by embankment materials eroded by rain water flashing.

The sedimented materials consist of sandy and clayey materials, which have reduced the canal capacities.

c) Office and necessary facilities

There are four sub-divisional areas in the Project Area. However, the sub-division office buildings are inadequately provided except these in Thatpat and Dera Murad Jamali. Furthermore, there are no facilities of communication between the offices. Also the means of transport, which are important for timely operation and maintenance, are insufficient in the Project Area.

2) Proposed Facilities for the Operation and Maintenance

a) Distribution facilities

According to the plan, each irrigation system will provide with four kinds of canals; the main canal, distributaries, minor canals and water courses. Furthermore, the water courses are classified into three types depending on the scale of their commandable area.

Distribution facilities should to be improved or newly constructed at the head of canals except the main canal. The distributaries are proposed regulating facilities with simple structures such as stop-logs instead of gate structures, and double orifice will be installed at the heads of the minors. Concerning the water courses, the modules shall be adapted at the heads of canals as a distribution facilities.

The construction costs for the proposed plan have been estimated in the Project cost.

b) Project facilities

For the activities of the proposed organization for operation and maintenance. The office building, communication facilities, means of transportation, etc., will be required as detailed in Appendix Table V.3-3.

V.3.3. Operation and Maintenance Cost

The operation and maintenance cost of the above-mentioned facilities and the organization are computed on the irrigation and the extension works except those costs of office building and communication system (wireless) and the details are shown as follows.

1) Cost for the Irrigation System

i)	Salary and Wages	Rs. 1,804,000
ii)	Transportation Facilities	2,944,000
iii)	Miscellaneous	379,000
iv)	Dreading of Sediment	1,520,000
	Total	Rs. 6,647,000

2) Cost for the Extension Services

i)	Salary and Wages	Rs. 2,720,000
ii)	Transportation Facilities	2,533,000
iii)	Miscellaneous	420,000
	Total	Rs. 5,673,000

3) Operation and maintenance cost during the construction period (3 years) in Stage I and Stage II of Construction Works

a) Cost for Irrigation System

	Stage I	Stage II
Salary and Wages	Rs. 595,000	Rs. 4,818,000
Miscellaneous	125,000	1,014,000
Dreading of Sediment	501,000	4,059,000
Transportation Facilities	2,944,000	-
Total	Rs.4,165,000	Rs. 9,892,000

b) Cost for Extension Services

	Stage I	Stage II
Salary and Wages	Rs. 897,000	Rs. 7,263,000
Miscellaneous	138,000	1,122,000
Transportation Facilities	2,533,000	-
Total	Rs.3,568,000	Rs. 8,385,000

V.4. Consulting Services

The consulting services will consist of the engineering services for final design, design and supervision of the Pilot Project and for supervision of the overall implementation of Stages-I and -II of the Project.

The consulting services will be rendered in the following four stages:

1) Final Design

The final detailed design of the Project as well as the preparation of tender documents will be carried out in a 12-month period starting from January, 1984. The well-qualified experts will be assigned to the Project including an irrigation engineer who will act as the team leader, and a hydrologist, design engineers, construction planning and cost estimate engineers, agronomists, soil scientists, and project economists.

2) Pilot Project

The final detailed design and construction supervision of the facilities for the Pilot Project will be made in a 20-month period starting from July, 1983. The qualified experts will be engaged is such services as the team leader, design engineers and those for other various fields.

3) Stage-I and -II Implementation

Construction supervision for the Project implementation and training of local counterpart personnels in all phases of the Project activities will be carried out in a 27-month period each for Stage-I and -II starting from September, 1985 and September, 1987,